Morphogenesis and Ecology

as a process of Architecture :Sea Sand Management strategies at Hout Bay

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Sea Sand Management strategies at Hout Bay

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I would like to thank my parents for their support, patience, and financial backing.

I would also like to thank the rest of my family and friends for their support and encouragement. This dissertation would not have come to fruition without the support of my loving family. Their encouragement and support throughout this whole period gave me the morale to work hard every day even when things got tough. It is because of these exceptional people that even my life at UCT was a comfortable one. I would like to thank all my friends who have been there and supported me throughout this period.

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I am very thankful and appreciative for all the assistance I have received and would not have been able to get this far without it.

Fig 1: Dissolving the boundary between man made and nature through a process of form making.

Dissertation Content:

This dissertation seeks to understand the boundary between nature and architecture and proposes that architecture has the potential to become a correlation point between man and nature. I would argue that the barriers between man and nature arise from a metaphorical and visual separation of the two components. I have investigated these boundaries through a theoretical desk study, contrasting the morphological, geological, and ecological aspect of nature to the norms and fanatics of architecture.

The study found that most manmade objects are created through Euclidean geometry, where form is derived and simplified through a mathematic process, whereas nature develops from adaptation and natural forces that has no limitation and is formed in an immensely complex manner. These two different processes create a geometric boundary between the two resultant forms.

As a result of this study I have proposed that we rethink architecture as building in opposition to nature and rather move towards an architecture that facilitates the processes of the natural environment and allows for the interaction between man and nature. This process will allow architecture to act as part of nature, and a point where people can interact with nature, instead of an individual object separate from the natural environment.

Introduction

Man's understanding of the complexity of nature has vastly developed due to the evolution of mathematics, biology and science.[1] Nature is often described through the lens of geology and natural living organisms. These organisms and geology exist and change with their own protocol with the condition that they adapt and adjust to. One as living organisms adapts to the conditions with the capacity of one's intelligence. However it is the intelligence that separated humans from the rest of the living organisms. Our development of technological solutions to improve human comfort alienates us from the rest of the natural environment. Over the years our shelter response has become an art, and the connection between nature and man was severed by the artificial intensity and the convenience of manmade technology. Architecture plays a large response in terms of human adaptation. It not only provides shelter and comfort to the human living, but creates an artificial identity. Architectural response to the natural environment has varied over time, however environmentally responsive design has only become common over the last few years as a response to the growing global awareness of environmental vulnerability. Although sustainable, environmentally responsive design is successful in reducing the detrimental actions towards the natural environment, it lacks visual sensibility and connection with nature.

Within this dissertation I propose to create a geometry that facilitates the process of natural growth and the change of nature. The possibility of architecture becoming part of a natural cycle allows the surrounding environment to settle and change with the building. An understanding of morphology and the ecological aspect of nature introduces the possibility of a new order and form making.

The new geometry and order mimicking the process of nature allows the building to react with the surrounding environment through form and materiality. The prediction of natural movement and incorporating into design allows a static form and space to change through the process of surrounding movements. From Architecture becoming a singular machine for living, instead it becomes a unified area for people to connect with nature. Prediction of natural movement through series of time will allow the geometry and space to be designed to accommodate series of experiences according to the surrounding development and allows architecture to be a point of human interaction with nature.

This argument is demonstrated by the conflict between nature's strength and the urban development in Hout Bay. The urban development after 1945 in Hout bay impeded and destroyed the circulation of the dune corridor.[2] Due to this development, Hout bay is currently experiencing a problematic intake of sand in the residential and public areas.

1 Strogatz, S. 2001. Exploring Complex Networks. Nature 410(8 March):268-276.

2 CSIR Research Report 428, Part 2 Synopses of available information on individual systems, Report no.29 (1988) Pg 22-32

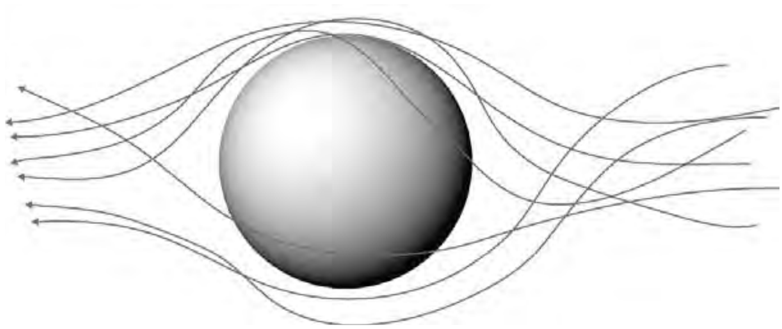


Fig 2: Natural force applied to a stone

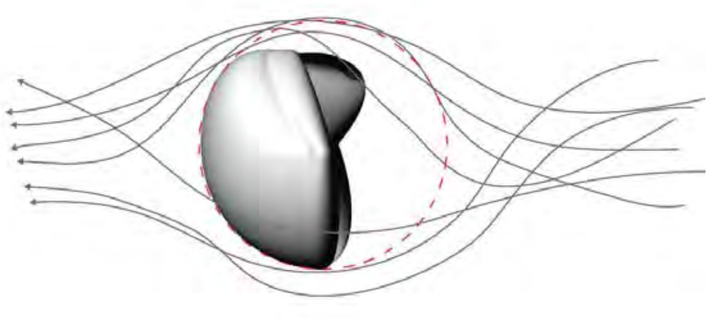


Fig 3: Change in form through natural

Architecture and Nature (Individuality and Differences)

Architecture and nature are processed through two radically different systems. Architectural systems are created through a defined, formal order, which allows form to function according to the use of space and programme, whereas natural systems and processes can be described as complex and informal. The order found within the structure of natural systems can only be understood once the pattern of infinite process is resolved.

Nature is a complex system, which we still do not completely understand. Natural process of growth has being influenced by many factors of environmental conditions. Each natural element reacts and interfaces with other natural elements, creating an interrelated link. Much growth development is determined by the surrounding natural processes and conflicting natural forces. Through this process, the living organisms build its diversity and character due to different conditions and adaptation, and form its individual geometric shape.[1]

The normative process of architecture is based on a simple system defined through columns, floors and stairs. Columns or walls to support the floor above, and floor slabs exist to divide the space vertically, and the stairs acts as a connector between each floor. Using this system, the designer explores a functional and ordered form.[2]

1 Norman H. Sleep, Dennis K. Bird, Evolutionary ecology during the rise of dioxygen in the Earth`s atmosphere, First Cite e-publishing, 2008 Pg. 1-2

2 Sou Fujimoto, T.I. (2008). Primitive Future: Sou Fujimoto. Tokyo: Izumi Akiyama. Pg 8-13

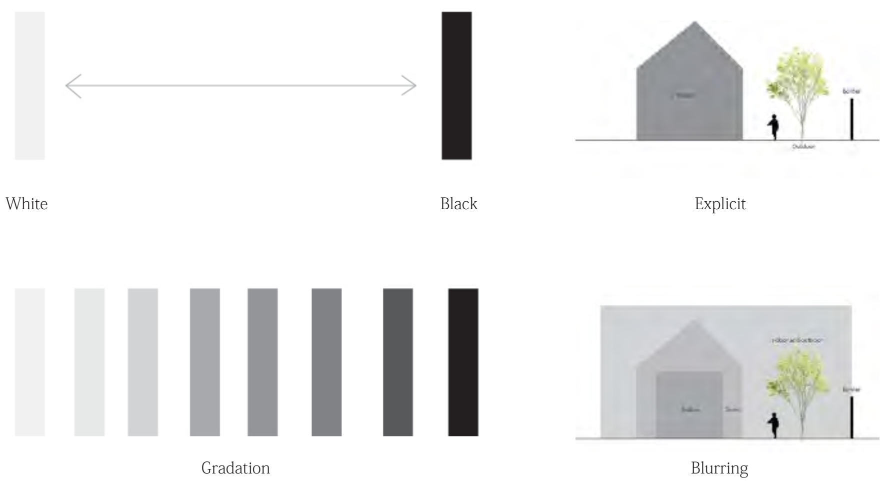


Fig 4: We see things as black or white, however what is important is to see the transition of colours to reach from white to black. Explicit geometry creates boundaries.

Fig 5: Architectural Grid

Fig 6: Natural Grid

In a primitive form of life, we used to consider caves and trees as shelter, and inhabit the space accordingly to the condition. Due to our intelligence, we adapted to a method of construction, which incorporated knowledge of nesting. This difference of cave and a nest determines the level of comfort and capability.

Caves are formed through a series of geological processes, such as erosion and abrasion of rocks through water, tectonic forces, natural acidic reactions, microorganisms, and any other atmospheric influences. Due to the instability of the cave, the living organisms struggle to habit in these spaces.[1]

Nest is a structural design constructed by animals to provide ones individual shelter. Although most of the nests are associated with birds, some of the other animals create their own nests too. Nests are often constructed through organic materials, and driven by a biological urge such as nesting instinct.[2] The complexity of nest construction is determined by the level and intensity of the parental care.[3] Dependent on the social structure the nest intensity and volume of space increases to accommodate numbers. Underground nests created by moles displays caste structure, which allows hundreds of individual to settle.[4] Nests are often separated into two types; sculpting and assembling. Sculpting is often done through a removal of material to create pockets of space, whereas, assembling is often constructed through multiple layers of weaving, with a material available to the immediate environment.[5]

Building can be seen as a nest for people, where people inhabit the spaces according to the designed programme. However the use of geometry, order, and material allows the building to be detached from the rest of the nest. Our intelligence enables us to simplify the geometry in to a liner form, and this decision divorced buildings from the rest of nature, and visually alienated us from nature.

1 British Geological Survey. Natural Environment Research Council. Avaialble at http://www.bgs.ac.uk/mendips/caveskarst/caveform.htm (accessed on 15 May 2014)
2 Liana Zanette, What do artificial nests tells us about nest predation? Biological Conservation 103 (2002) 323–329. Avaialble at http://publish.uwo.ca/~lzanette/Publications/Zanette_2002.pdf. (accessed on 15 July 2014)
3 Ibid. Pg. 323-329
4 Ibid. Pg. 330
5 Ibid. Pg. 330

Fig 7: Instability of a cave

Fig 8: Sculpting nest form

Fig 9: Assembling nest form

(Macro Scale of Nature) Growth, Change, and Ecology of Nature

Often we create and comprehend form and spaces through a Euclidean geometry, where everything is linear and easy to understand and use. In contrast in nature, all geometries are formed through a Non–Euclidean geometry where form is generated through a parametric relationship.[1] A parametric relationship is when a value of the variable corresponds to different distributions, and therefore when the parameter of the equation changes, the solution changes. In terms of nature, form is determined as solutions and the natural forces are set as parameters.

At a macro scale an understanding of geological evolution reveals the process and forms of nature. The geological formation of an area evolves through a complex process of deposition, and erosion over time.[2] This change in form sustains the geological system in nature.

A birth of living beings varies through areas as a different species, due to the different conditions and surroundings.[3] These systematic processes are most probably why nature is well balanced, as every element is considered and networked to create a balance in this ecosystem. The ability for living organisms to adapt to different conditions and surroundings and specialize over time creates a systematic process that ensures nature is well balanced, as every element is considered and networked to create a balance in this ecosystem.

This process can be used as an inspiration to create new order and systems in architecture. Understanding the cycles of nature and implementing them into a design strategy will create a solution that will dissolve the boundary between the two sides.

In understanding the cycles of macro scale natural systems I acknowledge that the building cannot act as a living organism, but can act as a static rock or a landscape which evolves through time by natural forces and facilitates the processes and cycles of living beings.

1 Soumitro Banerjee, 2009. Nature`s Geometry. Breakthrough, Vol13. No 4. Pg. 1-5
2 Reading, H. G., ed. (1996) Sedimentary Environments and Facies, third edition, Oxford: Blackwell. Pg 2-5
3Allen, J. R. L. (1968) Current Ripples: their relations to patterns of water and sediment motion, Amsterdam: North Holland. Pg.202

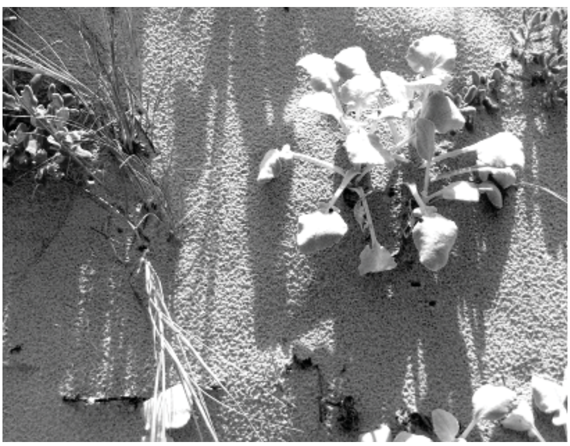


Fig 11: Network of nature's relationship

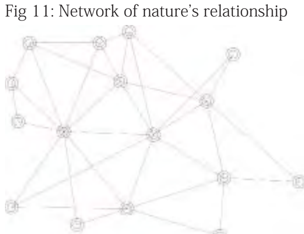


Fig 10: Connection between each plant and the influences.

Fig 12: Neignouring influences

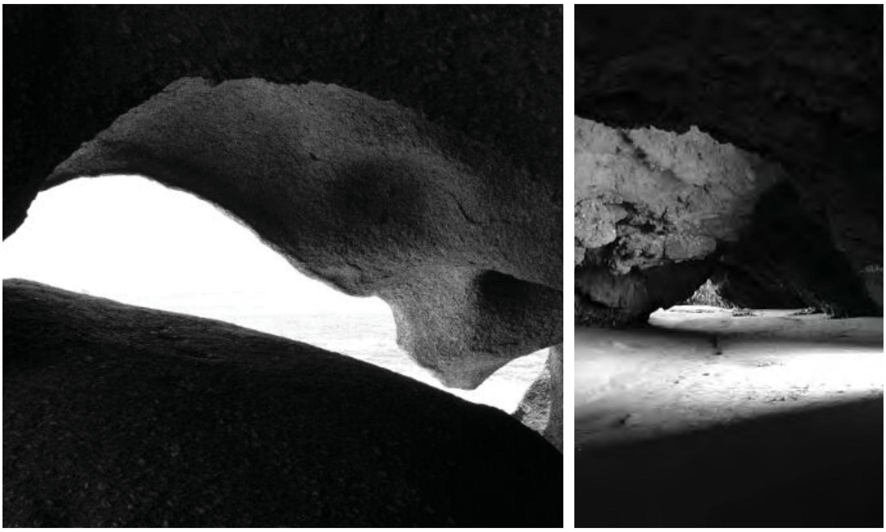


Fig 13: Rock forms a shelter through erosion.

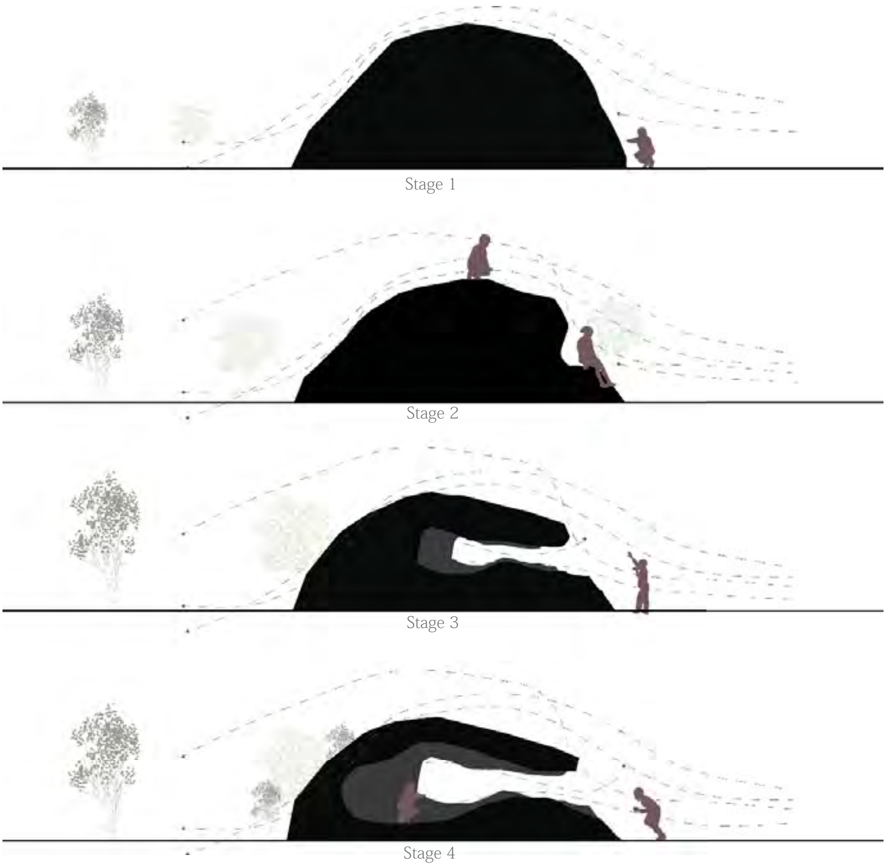


Fig 14: Neignouring influences

(Micro Scale of Nature)Process of growth in natural organisms

Natural organism is any contiguous living system. Most organisms are capable of some degree of response to reproduction, growth and development.[1] The process of growth in natural organisms occurs at a microscopic scale, nonetheless, as a designer it is important to understand this process. The growth of organisms is determined by the condition of the surrounding areas. At a microscopic scale, cells of natural organisms develop and change through an adaptation of their surrounding condition, and as a result the geometry of the organism is formed through an outcome of this process. [2]

These growth patterns can be analyzed through algorithmic pattern studies. All organisms have a pattern or a reaction system in their growth. When a certain force or a reaction is applied, the pattern starts shifting according to the reaction. These forces comprise any natural forces that would impact the growth of an organism. Due to these forces, the growth patterns are formed and the geometry of the organisms is created.

I have studied these reactions systems as patterns.

The use of mathematics can solve the growth pattern of individual organisms and define the similarities and differences of each organism's geometry. An example of a frequently occurring mathematical pattern is Voronoi cells. Voronoi cells are one of the patterns that are shared amongst most organisms. This pattern is created through a protective natural instinct of cell bonding. This system runs through most natural organisms and determined as one of the imperative pattern used in any natural growth.[3]

1 Norman H. Sleep, Dennis K. Bird (2008) Evolutionary ecology during the rise of dioxygen in the Earth`s atmosphere, First Cite e-publishing. Pg 2-4
2 Ibid. Pg. 3-5
3 Vincent, Julian. 2009. Biomimetic Patterns in Architectural Design. Architectural Design, 79(6):74-81,2014

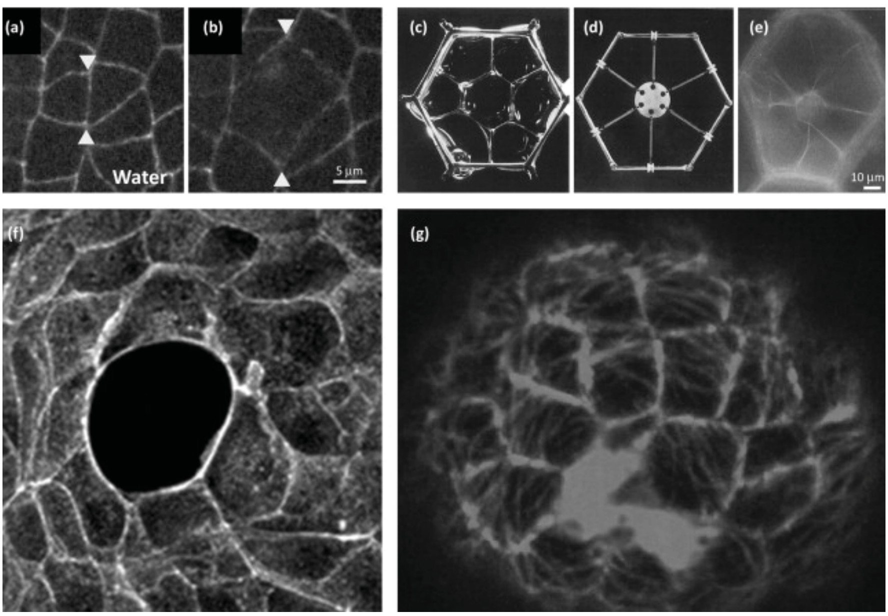


Fig 15: Process of Voronoi pattern forming in a cell

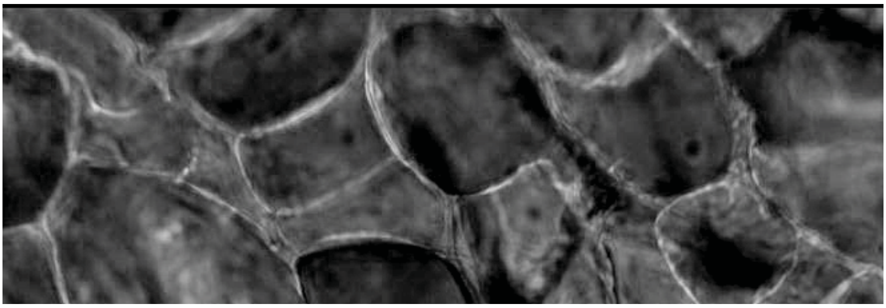


Fig 16: Cells connecting through a Vonoi pattern system

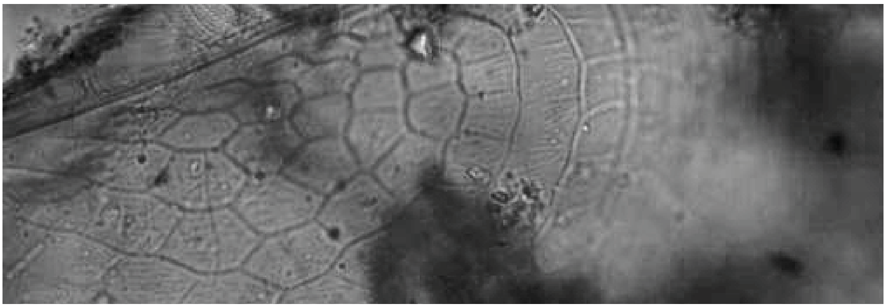


Fig 17: Leaves forming a vein in a Voronoi pattern

Fig 18: Dry mud cracking and forms a Voronoi pattern

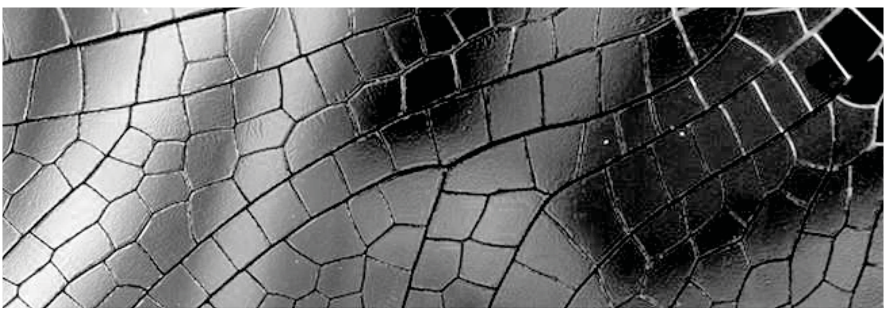


Fig 19: The wings of a dragonfly structured in a Voronoi pattern

Understanding Morphogenesis and Ecology of Nature as a process of Architecture

In order to interpret the understanding of Morphogenesis and Ecology into architectural form, the design process must involve computational and mathematical logic. The need to apply this logic to design comes from the fact that mathematics and physics is used to understand the bases of construction and the structure of the building. This is an absolutely natural affinity, as geometry is the most visual manifestation of mathematics.[1] The technology of computation allows people to reconnect architecture with geometry and provides opportunities to explore non-Euclidean geometries. In addition to more complex geometric forms the technology of computation also allows the possibility that other branches of mathematics, such as calculus and algorithms can be incorporated into a design.

From the technology of computation, we have more opportunities to explore in terms of geometric proportion through the feedback techniques and algorithms. This exploration of new geometry to create new spaces and forms through an investigation of non-linear path may lead to a new proportion and spatial organization. The use of computer into a process of design has impacted the culture largely, however at the same time a critical counterculture began to emerge. This new hybridized culture enhanced the tectonic, and created a new potential in architecture.[2] This was not only born through the algorithmic potential of computer programs, but of the tectonic capacities of actual materials. With time computer technology has merged with every aspect of architectural design and production, and now it is largely contributing into the realm of tectonics.

In this dissertation I have employed algorithmic design methods within a design process that uses nature's process as the basis of architectural morphology through computation in order to blur the boundaries between man and nature. This design process implements computational methods in response to ecology and the influential forces of the built environment and applying to the logic of the normative architectural process. The design will contain a non-Euclidean space making, as well as integration of building with the surrounding environment. By understanding the process of growth and the geometry of nature, and implementing into a design through a series of computational program and mathematical solutions, the geometric form of the building will lead to a closer relation the aesthetic of nature. Nevertheless nature involve vast amount of movement and change in geometry. In order for a design to be adapted and integrated into a moving system, I needed to predict and direct the movement to a certain extent to implement into architectural design. These predictions were made through series of experiments done through computation and practical analysis.

1 Ian Stewart, Does God Play Dice? The Mathematics of Chaos(Oxford: Basil Blackwell, 1989)
2 Neil Leach, David Turnbull, Chris Williams, 2004. Digital tectonics. Great Britain: Wiley-Academy, a division of John Wiley & Sons Ltd. pg. 6

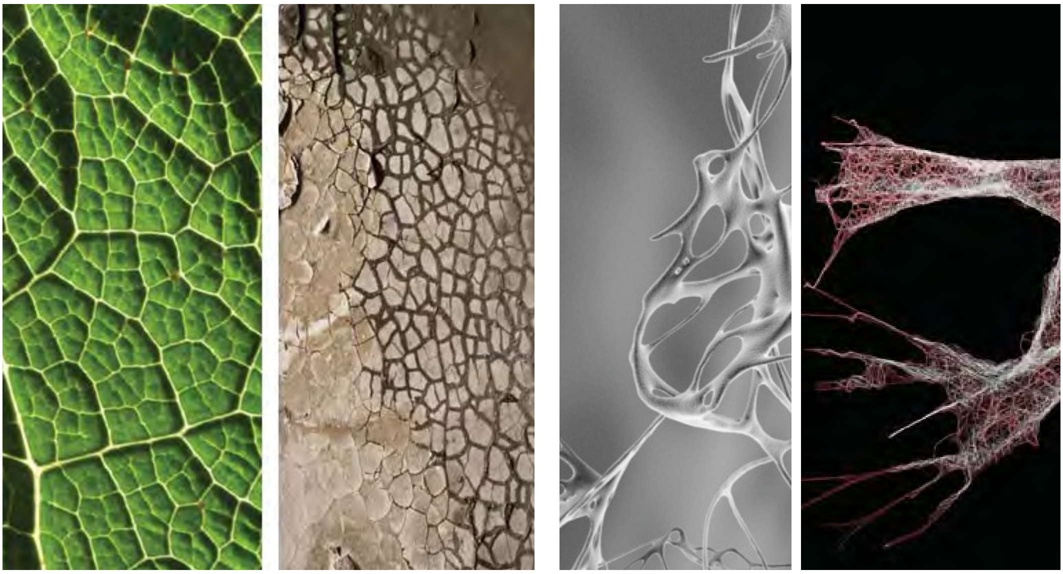


Fig 20: Nature's algorithm applied to a process

Site, context and identity

Choice of area and justification

The initial site selection strategy began by analyzing different types of geological location and conditions in Cape Town. In order to apply the research to a building, the area needed to provide a rapid movement and change in nature. Through investigation and research, the chosen site for intervention was to be positioned in Hout bay beach side.

Hout Bay is situated on the Atlantic seaboard of the Cape Peninsula, approximately 17km southwest of Cape Town. It is the only southward opening bay on the west coast of the Cape Peninsula. The area is populated mostly through residential and minimal public interventions are done in the area. There is an active fishing harbor in the northwest corner of the bay, which is helping the growth of the population in Hout Bay and had become one of the larger tourist attractions in Cape Town. However, due to extensive residential development, Hout Bay has struggled with the sand dune stability for several years. The city has proposed dune stabilization methods for numerous amounts of years, but the actions have never solved the problem. The city proposal has reduced the amount of sand in the area temporarily and has stabilized certain portion of the dunes. However the residents and the association of Hout Bay state that in order for the area to be solved, they need a radical and innovative change in the area.[1]

Before 1945, Hout bay used to be a pristine natural area, and the importance of the dune corridor was an important component of the natural ecosystem. This corridor works through a south easterly wind that occurs during summer to allow the sand to migrate from Hout bay to Sandy bay. This migration of sand balanced the sand distribution between the two bays located on opposing sides of the peninsular.[2] The major urbanization occurred after 1945 blocked of the circulation and caused a major problem with sand distribution. Because of this extensive urbanization sand now accumulates in Hout Bay causing sand overflow into residential areas while Sandy Bay is becoming a problem due to the lack of sand in the on the beach.

This condition of the Hout Bay sand dune migration route reflects on the conflict between nature and architectural development. My proposal is to allow my design to apply a possible long-term solution to the area, and to represent a new possibility of architectural development through an understanding of natural condition and the system itself.

1 News from Residents Association of Hout Bay, Hout and About (2008). Available at http://www.houtbay.org.za/Newsletters/200801_HoutAbout.htm . (accessed on 26 August 2014)

2 Michael R. Machutchon, The Geological Evolution and Sedimentary Dynamics of Hout Bay, South Africa.(2012) Available at http://uctscholar.uct.ac.za/PDF/93317_Machutcheon_M.pdf. (accessed on 16 April 2014)

Fig 21: 1903 Photograph of Hout Bay

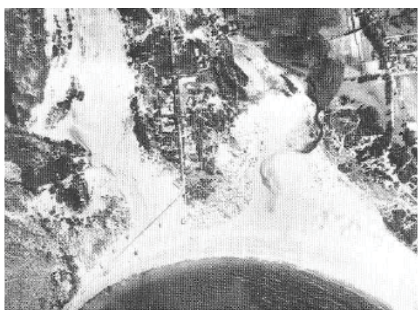


Fig 22: 1944 aerial photograph

Fig 23:1903 aerial photograph of Hout Bay

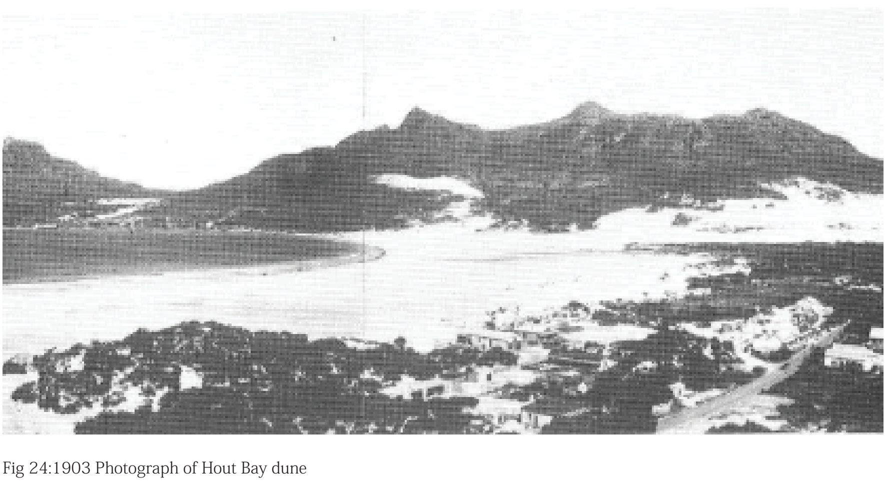


Fig 24:1903 Photograph of Hout Bay dune

Fig 25:1945: Existance of a sand dune corridor

Fig 26: 2012: Urban development blocks the sand dune

Fig 27: 2012 Hout Bay

Fig 28: 2014: Buildings destroyed due to the overflow of

Fig 29: 2014: Sand overflowing on to the road

Urban Development over time and change

Hout Bay has changed from a rural to a semi-urban environment, and there has been a drastic shift in land-use from agricultural to a more of a residential area. As the year goes by, the residential area increases and the sand corridor area and the natural habitation decreased.[1] Although Hout Bay accommodates only 0.53% of the population of Metropolitan Cape Town, the unique natural environment in the area and the development of the residential land has created a unique quality to an area.[2] Therefore it is important to sustain the existing natural environment in Hout Bay to retain the quality of nature.

The analysis of the development in Hout Bay from 1944 to 1983 affirms an immense shift in land use from agricultural and Forest to residential.[3] The area of the sand corridor decreased from 1.44km2 to 0.41km2 within 39 years period, and the residential areas increased from 0.24km2 to 2.64km2.[4] Due to the blockage of corridor circulation, sand is overflowing onto the road and the residential blocks. Sand blown from deflating dunes have continuously over flowed onto Harbor road and adjacent properties, and in 1956, the movement of the dunes became a massive issue by the Beach Estate.[5] Through time, the construction of a sea wall and a hardened parking area has given some protection towards these houses but broke the connection point between the road and the beachfront. The past intervention has temporarily fixed the situation, however the solution to the dune stabilization and sand transfer is still needed to be achieved.

1 CSIR Research Report 428, Part 2 Synopses of available information on individual systems, Report no.29 (1988) 27-29
2 Ibid. Pg. 22
3 Ibid. Pg. 27-29
4 Ibid. Pg. 30
5 Ibid. Pg. 31

Fig 30: Analysis on 1944

Fig 31; Analysis on 1958

Fig 32: Analysis on 1977

Fig 33: Analysis on 1983

	1944		1958		1968		1977		1983	
	Km2	%	km2	%	km2	%	Km2	%	Km2	%
Forest / Plantation	1.75	5.2	2.04	6	*	*	3.75	10.6	*	*
Cultivated lands	1.04	3.1	3.53	10.4	0.9	2.7	9.8	2.9	0.48	1.14
Residential areas	2.4	0.7	0.67	2	1.35	4	1.46	4.3	2.64	7.8
Sand Corriodr	1.44	4.3	0.9	2.7	0.85	2.5	0.7	2.1	0.41	1.2

Fig 34: Chart showing the land use development of Hout bay from 1944 - 1983

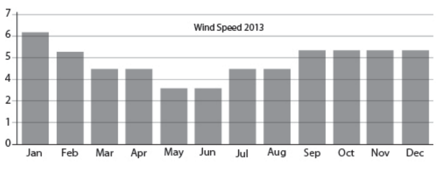
Geological, weather condition and sand analysis

Hout Bay has a substantial accumulation of Quaternary sediments on the Atlantic Seaboard of the Cape Peninsula.[1] The sediment transported by long shore drift in Hout Bay has a medium to fine grained fractions mostly along the beach. From the research of the geologist, a portion of this accumulation is then entrained by Aeolian vectors into the headland bypass, and to be re-introduced into the marine conveyor near Sandy Bay, yet the majority of the sand continues along the western flank of the bay.[2] The migration of the dunes into the headland bypass dune field between Hout Bay and Sandy Bay is being over flowed by the introduction of invasive dune vegetation and the urban development.

Meteorological effects originating offshore in the Atlantic and Southern Oceans primarily influences the climatic condition in Hout Bay.[3] During Summer Hout Bay is overly dominated by the South Easterly wind, and in winter the South Atlantic high moves north-west, and north-westerly wind occurs. This natural wind movement creates the sand dune circulation along the corridor between Hout Bay and Sandy Bay. Hout Bay experiences a typical Mediterranean climate, with dry, hot summers and cold, wet winters. From the research, rainfall data collected from the South African Weather Service for Hout Bay illustrated the estimated data span of 57 years and showed that summer rainfall is between 30 and 50mm per month, whilst winter rainfall is between 200 and 270mm per month.[4] The wind velocity decreases extensively from summer to winter. This result extensively shows that the sand is transferred mostly during summer, due to the wet condition and minimal wind movement in winter.

The study of sand sampling along the beachside and the research of the geologist, Michael MacHutchon, reveal the accumulation and erosion of sand area, and the study of the wave pattern of Hout Bay beach showed a clear result of a westward wave along the beach. The study indicated a clear analysis of sand accumulating on the East side of the beach due to the western directional wave and the South Easterly carries the sand in a North-West direction. This result shows the reasoning behind the dune formation and the sand overflow by the roads. The sand grain sizes from the area showed the understanding of different sizes of sand grain per area relative to the surrounding conditions, and allowed to predict the type of behavior the sand occurs per area.

1 Michael R. Machutchon, The Geological Evolution and Sedimentary Dynamics of Hout Bay, South Africa.(2012) Available at http://uctscholar.uct.ac.za/PDF/93317_Machutcheon_M.pdf. (accessed on 16 April 2014)
2 Ibid. Pg. 121-123
3 Ibid. Pg. 124
4 Ibid. Pg. 124



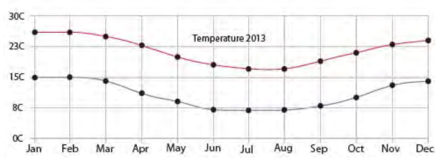


Fig 35: 2013 analysis on wind speed and temperature

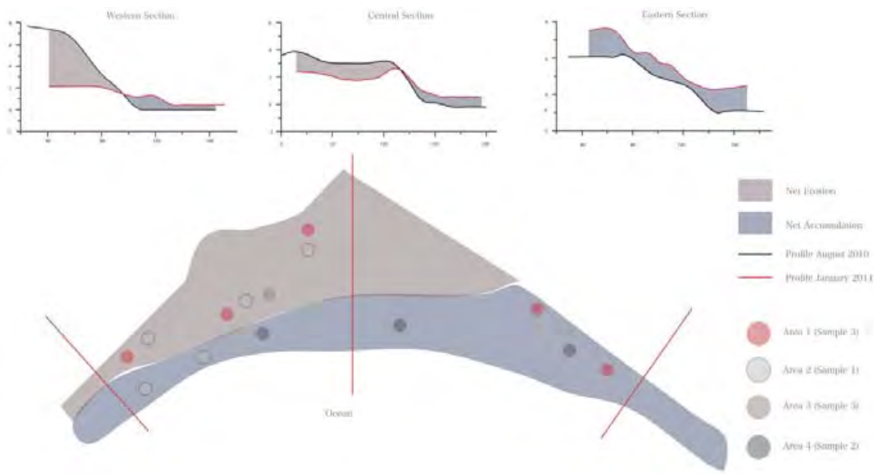


Fig 36: Sand Sample collection and accummulation analysis

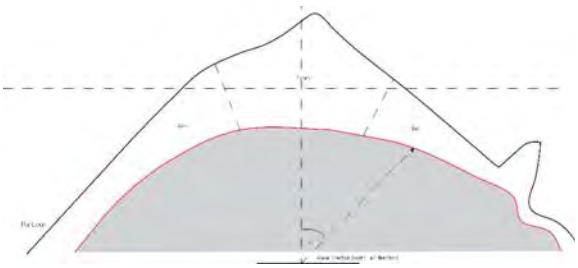


Fig 37: Sea wave direction

Fig 40: Sample 1

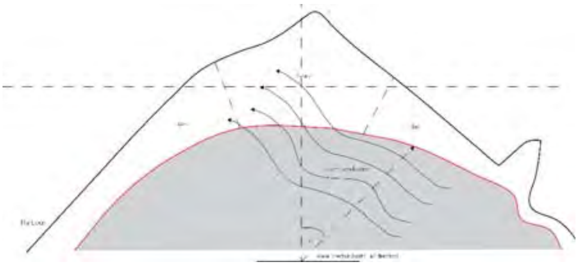


Fig 38: Wind direction

Fig 41: Sample 2

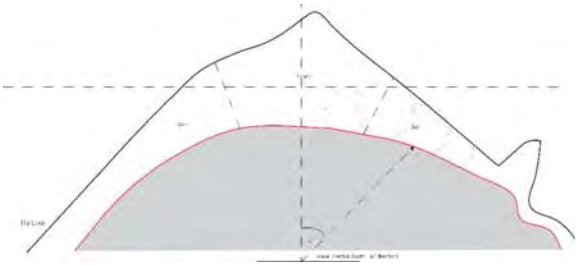


Fig 39: Sand accumulation area

Fig 42: Sample 3

Fig 43: This analysis is showing the sand spill in Hout Bay. The over lay of urban development and the historical sand dune corridor. The access point to the corridor from the road is situated accordingly.

Fig 44: This analysis is showing the circulation of the south easterly wind during Summer. The wind direction reverses during Winter due to the high pressure cells moving north-east.

Fig 45: This analysis is showing the vehicular and pedestrian circulation. The dotted orange line is the pedestrian pathway that is used, and the red showing the road. The black line is showing the urban edge in conjunction with the sand corridor.

Fig 46: This analysis is showing the vegetation and the river flows in Hout bay. Sand corridor were not only reduced by the urban development, but also by plantation.

Site selection and analysis

Hout Bay is a small community compared to the rest of Cape Town, and the residential complexes and houses occupy most of the area. Public facilities are concentrated around the harbor as this area attracts tourists. From the investigation of sand movement, the accumulation and movement of sand was rapid towards the east side of the beach, this supported my decision to channel the sand through an existing tunnel crossing under the Harbor road. The architectural intervention will be along the ephemeral river situated perpendicular to Harbor road. This site is situated perpendicular the Harbor road, which is one of the busiest road in Hout Bay due to the tourist and local attraction in the harbor and the North shore drive. The site sits in a small valley approximation of 4 meter, with a gradient of 60 degrees. The heavy rainfall and the flow of the river during winter eroded the area and created a valley to allow sand to travel during summer.

The constraints and opportunities of the site comprises: the site itself along the river is not well maintained, and people in the area do not interact with the river due to the lack of accessibility and visual aesthetics of the area. During summer the river is dry due to the lack of rain, and mostly filled with sand and vegetation. In winter the river becomes active and sand gets eroded through the flow of the river. This excessive modification of seasonal change creates a unique opportunities on site. This site also have a potential to use as a corridor to transfer sand from Hout bay to the midway dune higher up towards Sandy Bay. In terms of public interaction, the site is situated opposite the harbor, which has a potential to attract people to interact with nature and use as a public attraction facility.

The issues on site are evident, the unstable sand dune needed to be treated; the river needs to be maintained and to maintain the existing trees and plantation as much as possible. Consideration of the existing ecosystem and dealing with the natural forces acting on site was crucial.

Fig 47: River flowing on site

Fig 48: Beach side

Fig 49: Existing tunnel for the river and sand flow

Fig 50: The analysis is showing the vehicular circulation around the site, showing accessability.

Fig 51: The analysis is showing the sand spill and sand dune areas. The diagram also shows the height of each gradient around the site.

Fig 52: The analysis is showing the south easterly wind circulation on site

Fig 53: The analysis is showing the typology and program around the site. The result emphasizes the intensity of residential areas comparison to the number of public facilities around the site.

Urban / Landscape Framework proposal:

Recreating the corridor to channel the sand from Hout Bay to Sandy Bay

The historical existence of the sand migration corridor became the design inspiration and created a possible solution to the sand accumulation issue of Hout Bay. My proposal of recreating a manmade corridor to allow the sand to travel from Hout Bay to Sandy Bay will create a possible solution to the accumulation of sand in Hout Bay and the erosion in Sandy Bay. The corridor is created in order to direct of the flow. The sand will gradually flow through the corridor by the use of the natural wind from the South East. This corridor will become the anchor point to connect Hout Bay and Sandy Bay, and the accessibility between the two sides will be increased due to the public pathway created along with the corridor to allow people to interact and experience the sand and the natural environment.

Along the proposed pathway, there will be 4 towers set in a position to act as a beacon to allow the person to identify as an access point to the pathway. These towers are designed to improve the ventilation of the corridor through architectural intervention and designed in order to allow for resting or pause points, linking natural and human requirements and bridging the perceived boundary that exists between these two grounds. The tower is 15m high and located in an area where it is visible from all around Hout Bay.

Fig 54: View from the existing corridor looking into Sandy Bay

Fig 55: Existing corridor, midway.

Fig 56: The framework of this proposal is emphasized on the corridor and accessablity. The towers are located accordingly

Channeling wall design along the beachfront

The stepped wall is designed along the beach to redirect the sand to the mouth of the site. The East accumulation and the South Easterly wind will transport the sand from Eastern to Western side of the beach and enable the sand to accumulate along the proposed corridor. The wall is stepped to allow people to use as a seating area or any other use. The wall geometry will break-down over time due to the accumulation of sand during the transfer and the sand will accumulate along the stairs and the stairs will gradually change into a slope of sand. This concept of accumulation was inspired through a dune system. Creating an artificial dune along the beach by creating these steps allows the sand to travel from East to West, and people will adapt to the use of steps according to the amount of accumulation of sand on the steps.

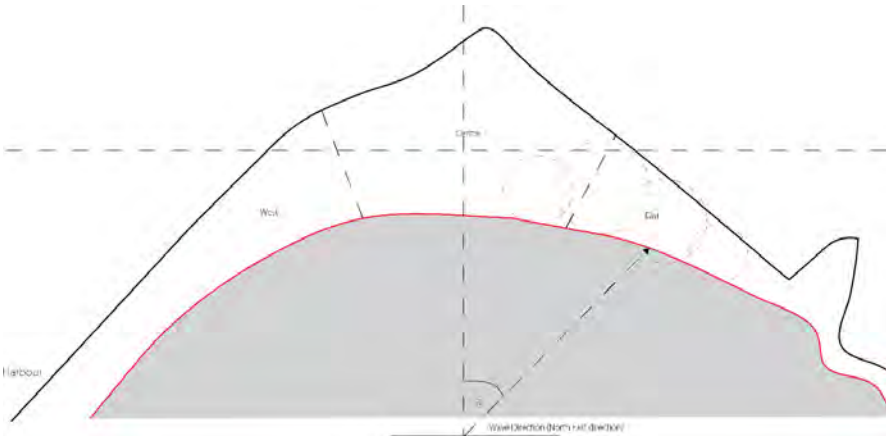


Fig 57: Accumulation point

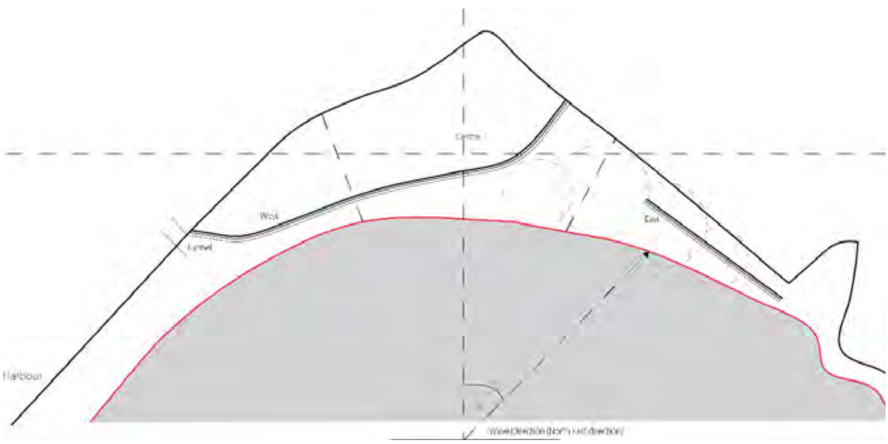


Fig 58: Proposed wall to direct the sand

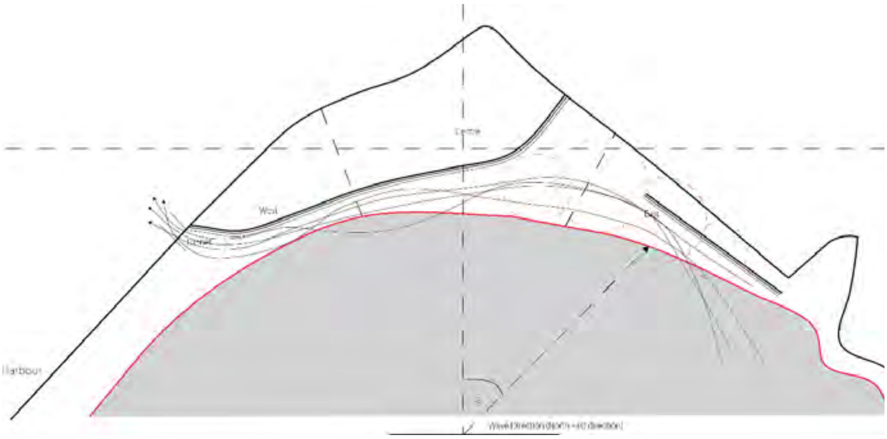


Fig 59: Assumption of circulation

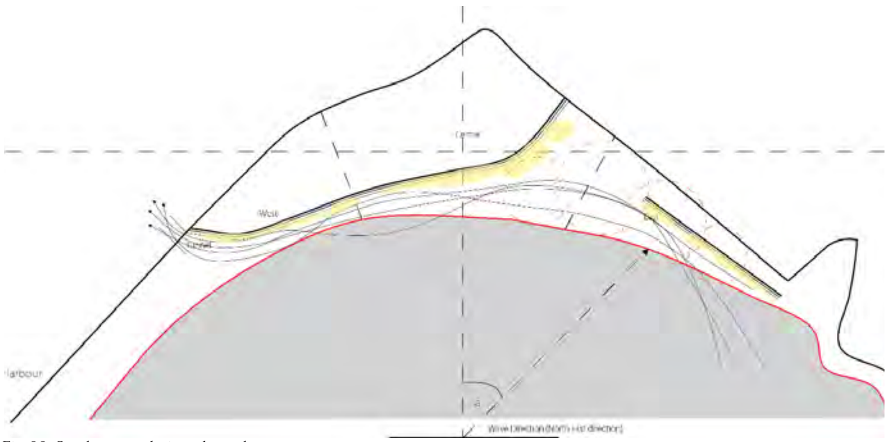


Fig 60: Sand accumulation along the movement.

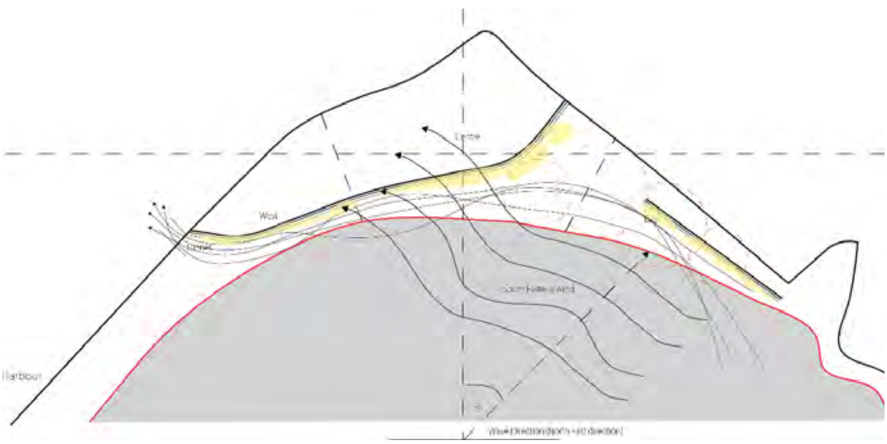


Fig 61: proposed sand flow

Architectural design process and programme:

Programme

The aim of this dissertation is to design with nature and to question how a building can be designed to react to the surrounding natural environment. The poetry of this dissertation is to design a building with sand, and an idea of using the existing site material for an innovative intervention. The program of the building is designed to bridge the gap between man and nature by attracting people to a research facility for the unstable dune system and to interact with nature on site.

Fig 62: Possiblity of site ceoming a public zone, due to the harbor attraction

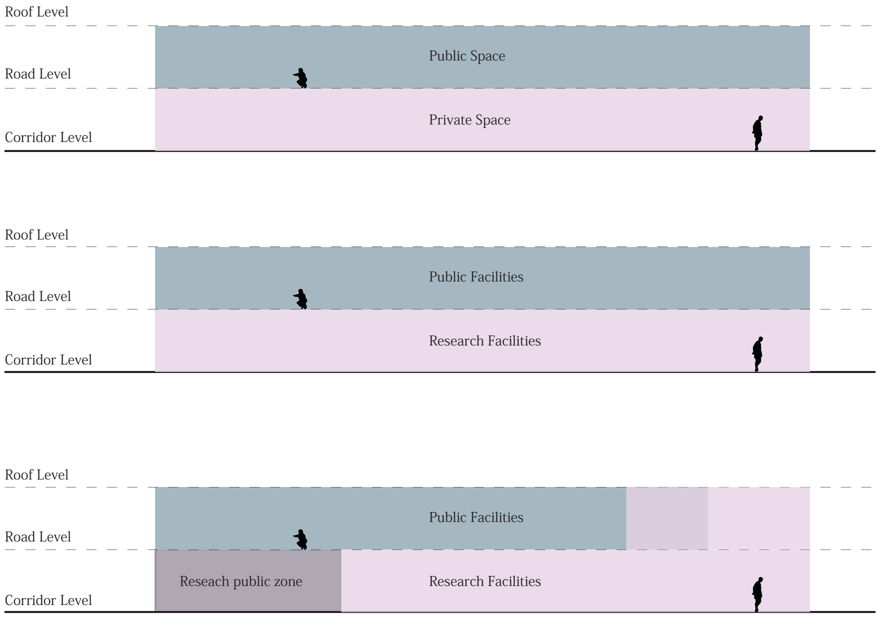


Fig 63: Diagramatic spatial relation

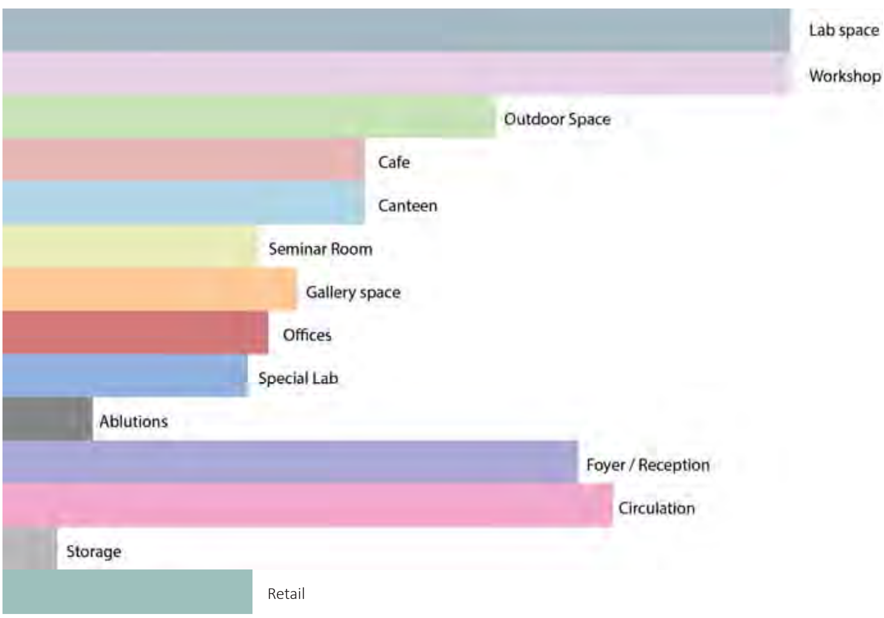


Fig 64: Diagramatic spatial size

Experiments and Investigations of Sand Movement

The architectural intervention of this dissertation is based on an analysis of research and experiments. The result of these experiments and investigations are used and analyzed throughout the design process.

Sand dune investigation and formation:

Sand dunes are formed through a substantial amount of sand, wind, and an obstacle to allow the sand to settle. These formations are different according to the obstacle and the wind direction. There are three types of sand transfer. The most common type is saltation; the sand grain bounces along the surface until it reaches its settlement. 95% of the transfers are made through Saltation, and 4% of the sand moves through Creeping.[1] Creep is when the sand grain collides with other grains and moves through these collisions. The 1% of the sand suspends of ground and travels up in the air. However these sands are extremely small in grain, and the velocity of the wind needs to be greater than the gravitational force per mass.[2] Once the sand starts moving, the sand will continue travelling until it clashes into an obstacle. Generally the heavier grain settles onto the obstacle, and the lighter grain settles on the other side of the obstacle due to the break of wind. Once the sand accumulates along the obstacle, the dune is formed.

1 John Mangimeli, Geology of Sand Dunes, White Sand National Monument (2007). Available at http://www.nps.gov/whsa/naturescience/upload/Geology%20of%20Sand%20Dunes.pdf. (accessed on 16 April 2014)
2 Ibid. Pg. 2

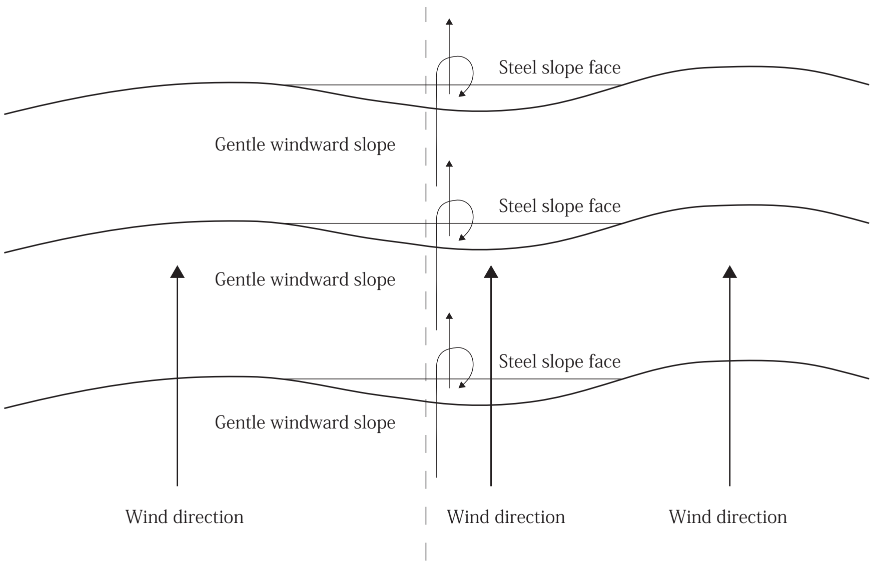


Fig 65: Transverse dune type

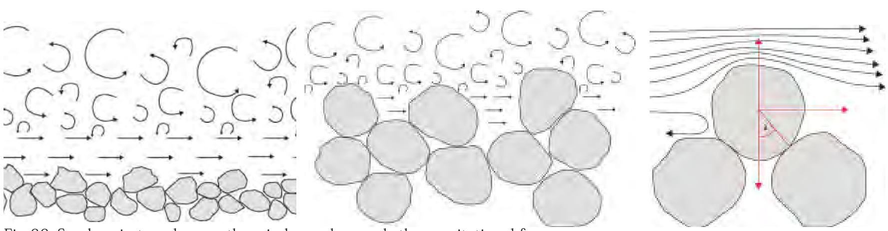


Fig 66: Sand grain travels once the wind speed exceeds the gravitational force.

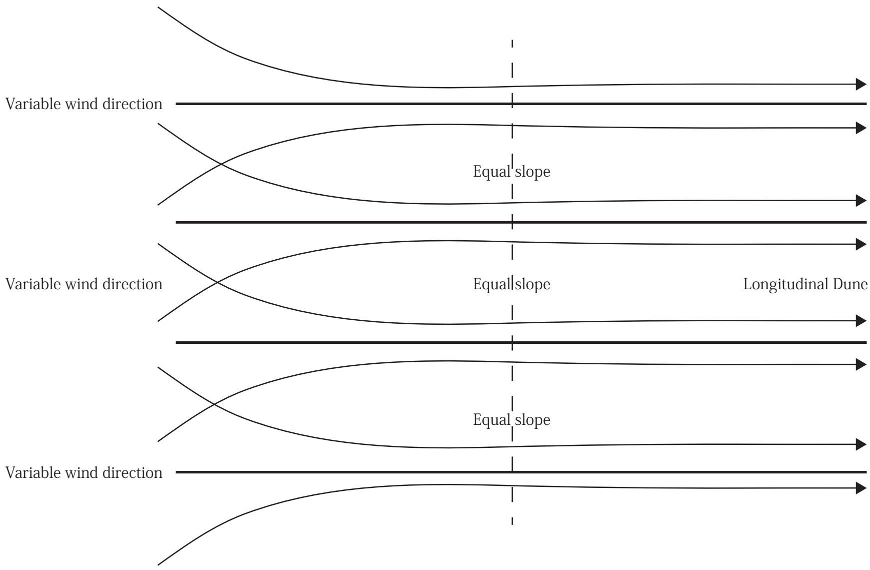


Fig 67: Transverse dune type

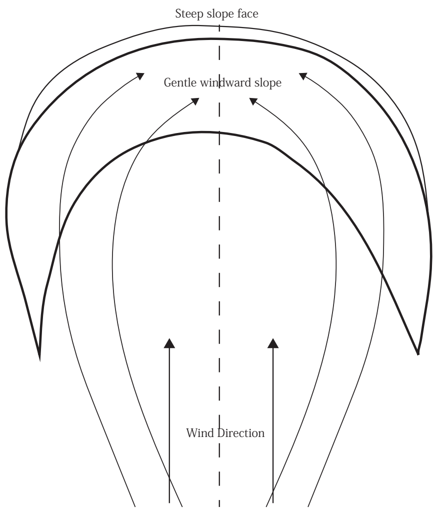


Fig 68: Blowout dune type

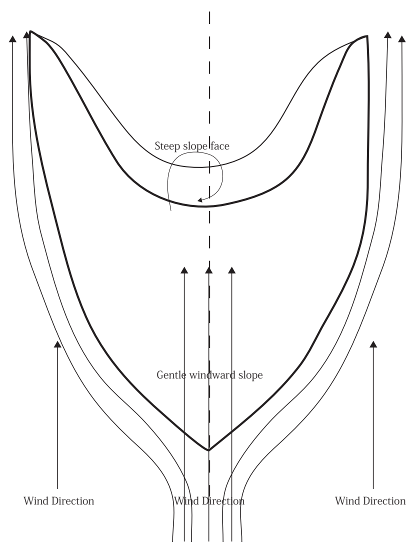


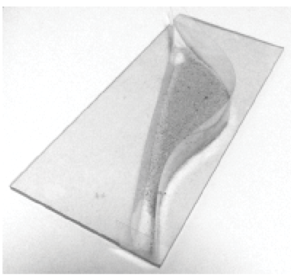
Fig 69: Barchan dune type

Sand accumulation through different obstacles:

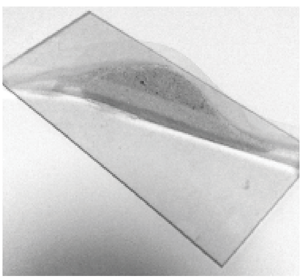
The study of dune formation enabled me to investigate how sand collects around obstacles and how it reacts to these obstacles. These obstacles can potentially act as a roof, wall or a column where the sand accumulates and changes the geometry of the building over time. The sand accumulates and forms its shape around the geometry of architectural obstacles and creates an organic geometry around a linear geometric form. This movement of accumulation and erosion of sand allows the building form to change over time and allows the person to experience the geometric modification of this building.

Fig 70: View showing the accumulation on walls

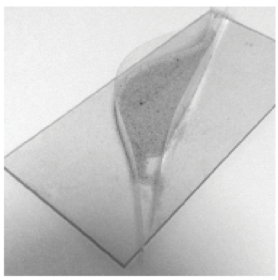
Fig 71: View showing the accumulation on columns



Model view 1

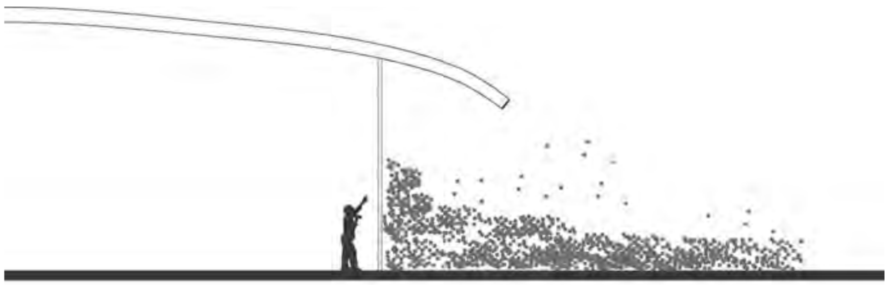


Model view 2

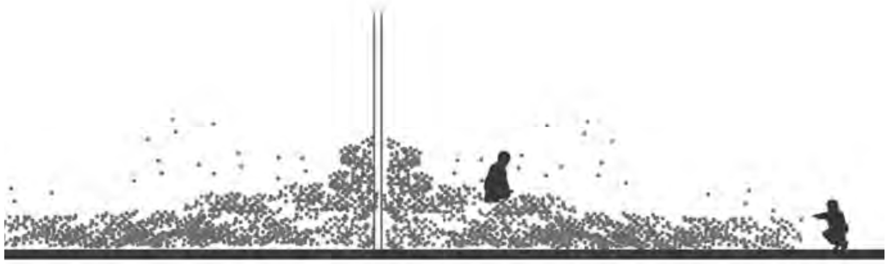


Model view 3

Fig 72: Physical model



Accumulation on glass wall



Accumulation on columns

Accumulation on a roof

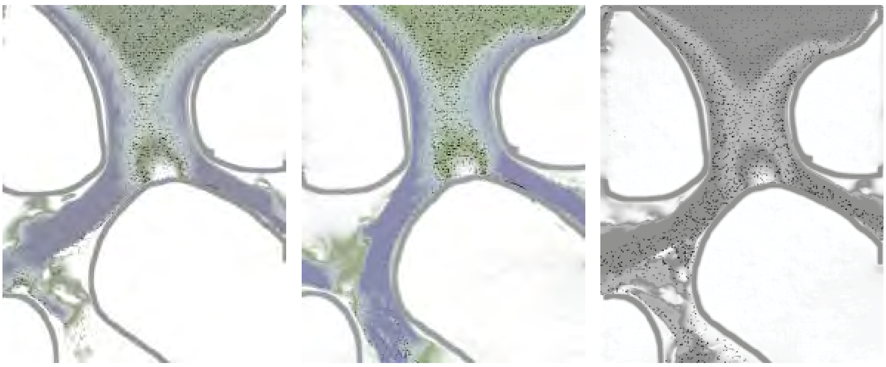
Accumulation on a stair

Fig 73: Types of sand accummulation

Experimentation of corridor forms:

The proposed sand corridor is thought through in a process of fluidity and geometry. The study of wind tunnels through a program called Wtunnel allowed me to analyze the accumulation and fluidity levels of different geometric tunnel possibilities. The result of this analysis allowed me to form it shape of a corridor and with a help of an Aeronautical Engineer, it helped me to determine the estimated amount of accumulation of sand per area. The sand accumulation calculation per area, through an equation of Bagnold`s formula resulted in a minimal accumulation per day per area. This slow process of transformation was necessary due to the current ecosystem on site. Ecosystem of the site can only be modified gradually to reduce the harm in the area.

By combining the analysis of the sand dune, sand samples and the experimentation of these corridors, it resulted in a step corridor method. This method allows the corridor to accumulate according to the grain size. The levels of these corridors are set according to the three sand transfer methods.



Stage 1 Stage 2 Stage3

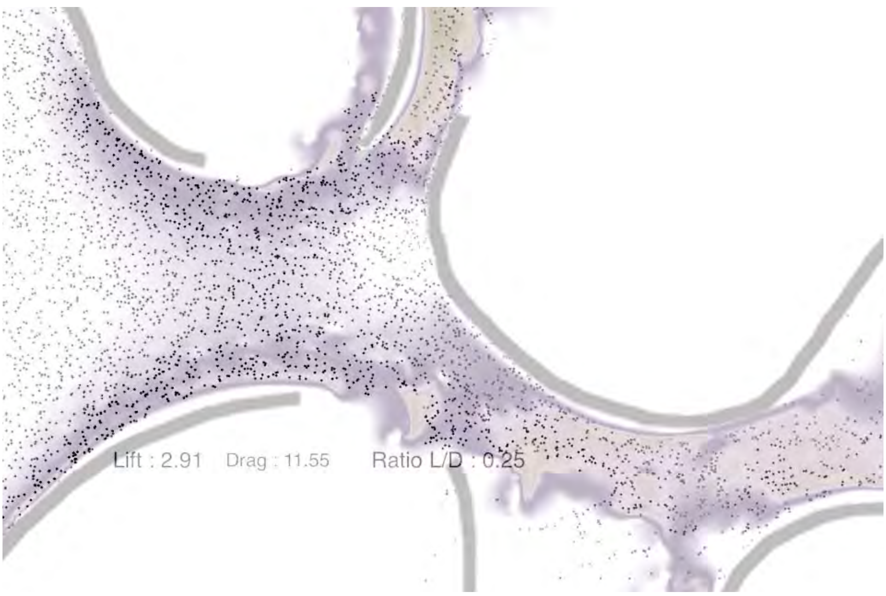


Fig 74: Sand fluidity and circulation analysis. Wind velocity increases as the corridor gets smaller, and sand travels further due to increase in wind speed.

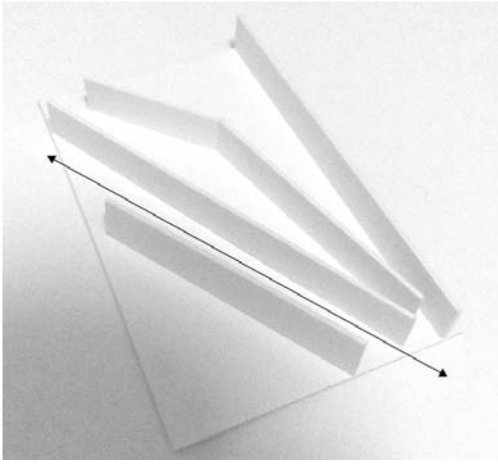


Fig 75: Straight corridor: it flows but very few accumulation

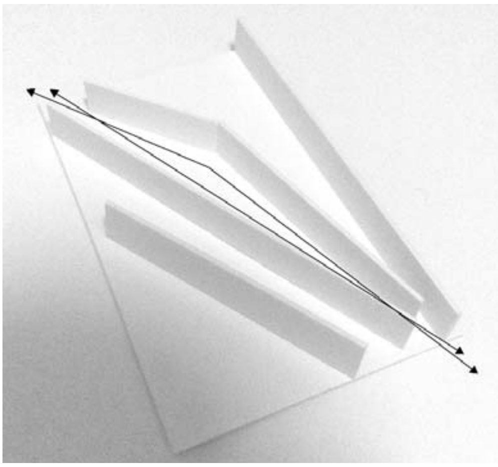


Fig 76: Irregular corridor: sand accumulates in the angled area.

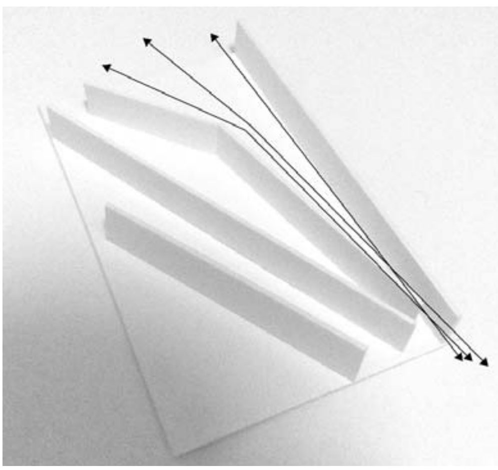
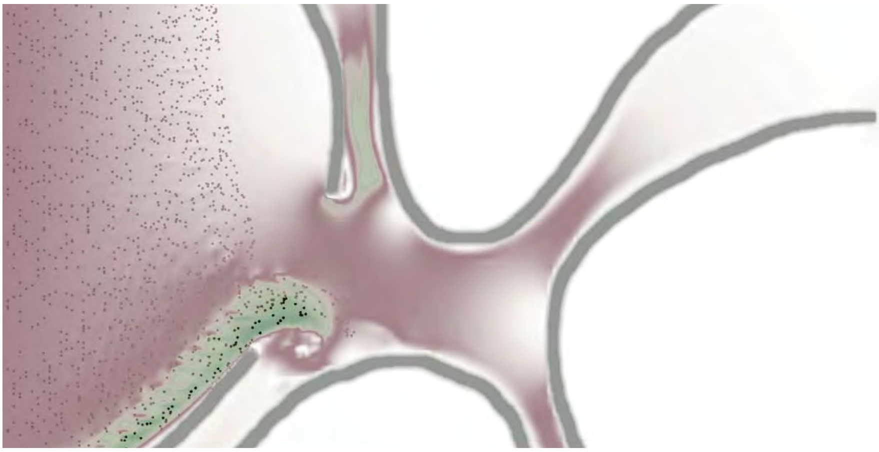
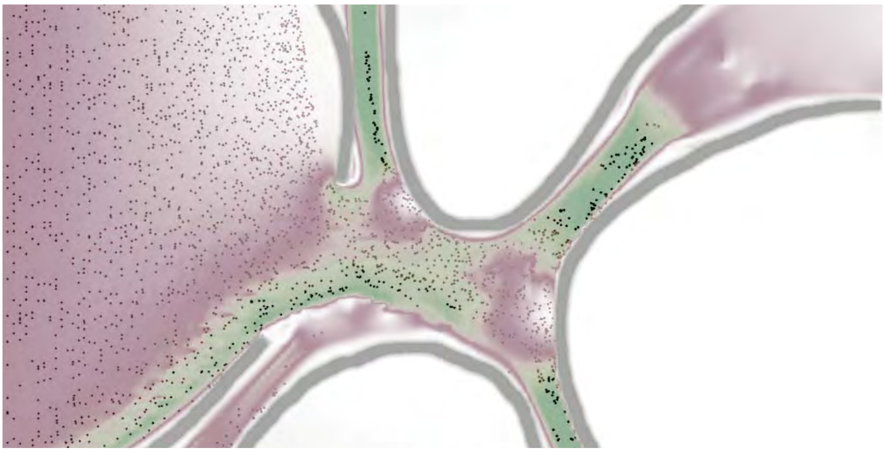


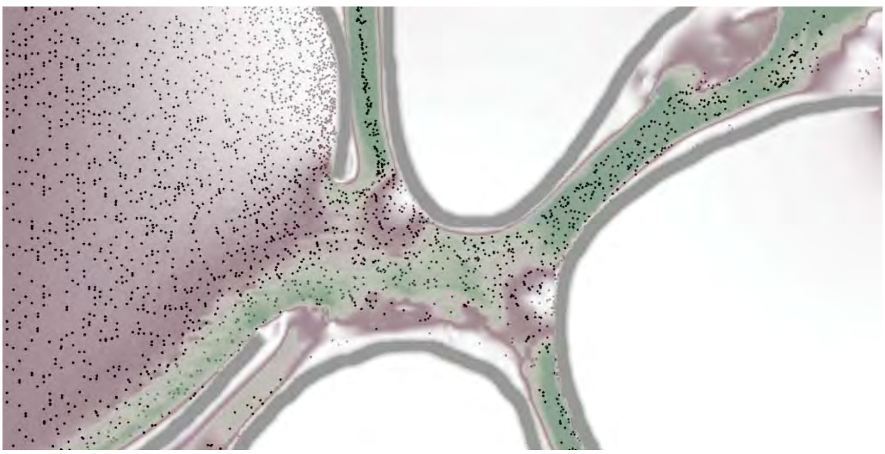
Fig 77: Funnel type corridor: Wind speed increase and releases and sand spreads as the area of the corridor increases.



Stage 1



Stage 2



Stage 3

Fig 78: Fluidity experience

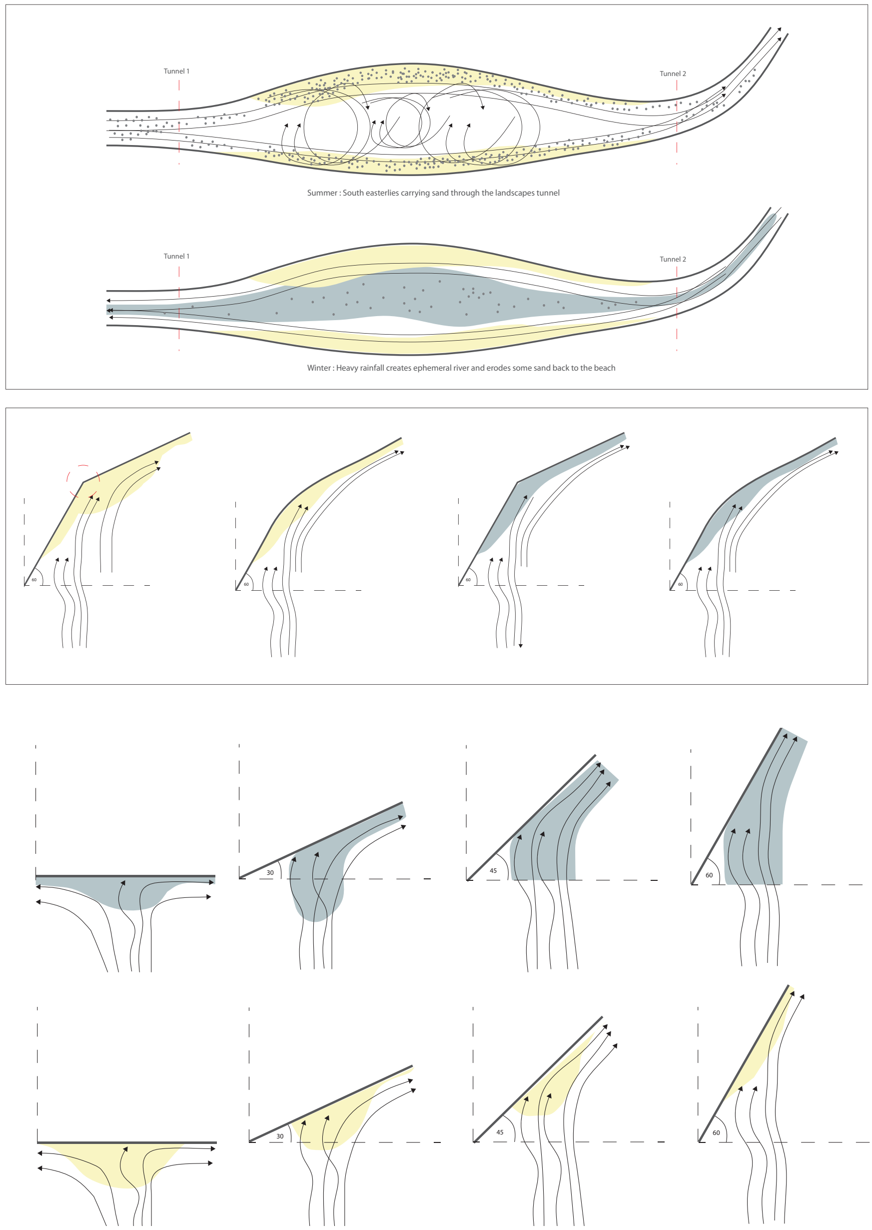


Fig 79: During summer sand travels through the corridor and accumulates according to certain angles. During winter the river becomes active and certain amount of sand gets eroded back. The angle determines the accumulation level.

This corridor is designed to accommodate the accumulation of sand during summer, and to allow the river to flow during winter. The process of sand moving from Hout Bay to Sandy Bay will be exceedingly slow due to several natural forces of erosion and surface flows. However this slow process is the positive outcome for the natural environment.

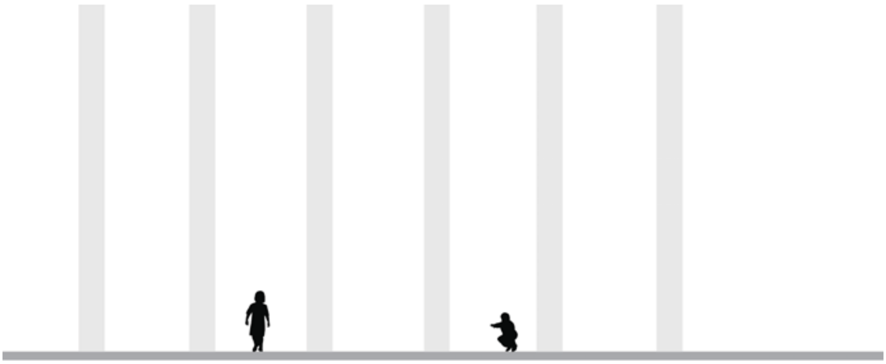
Spatial investigation (Creating spaces outside the norm)

During the design process, I have investigated the different qualities and characteristics of geometry and spaces. All of these spatial experiments are testing the limit of a normative architectural design and creating new order and spatial qualities through an inspiration of nature's formation.

Spatial Experiment 1: (Ordered columns and irregular columns)

The spatial quality of the two shows clear characteristics of a formal and informal space making. Both column placements are ordered but ordered in a distinctive way. The ordered columns through a normative grid system creates order and formality, however irregular columns, has an order but creates playful spaces and blurs the boundary between each spaces.

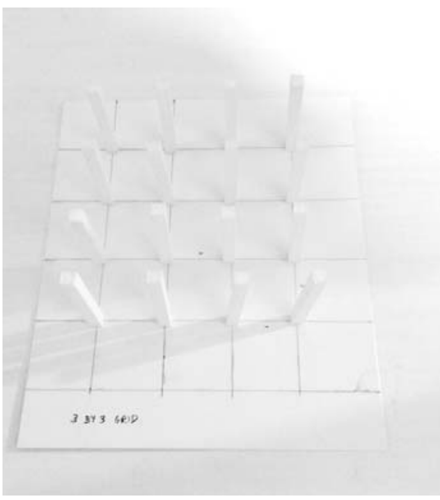
Fig 80: Irregular column spatial view



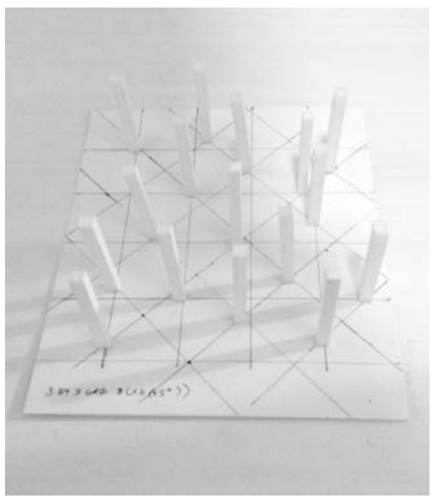
Standard grid columns

Off grid columns

Fig 81: Sectional Diagram



Standard grid model



Off grid model

Fig 82: Physical Model

Spatial Experiment 2: (Layering of geometry)

This is a study of how a wall becomes a roof and a roof becoming a wall. Nothing is defined and simply set according to gravity. The spaces that are created through this geometry have unique spaces, however difficult to make it functional.

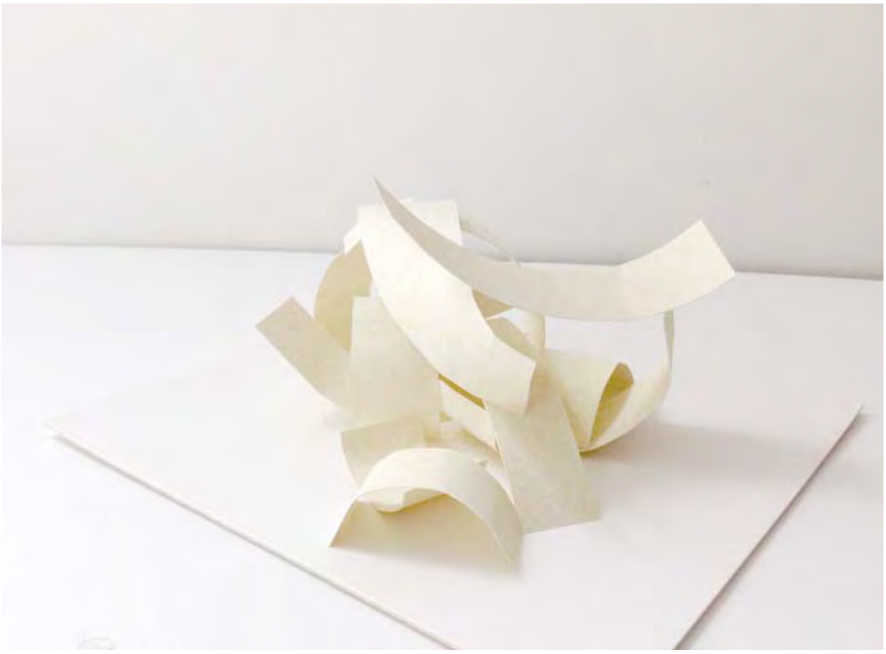


Fig 83: Physical model view 1

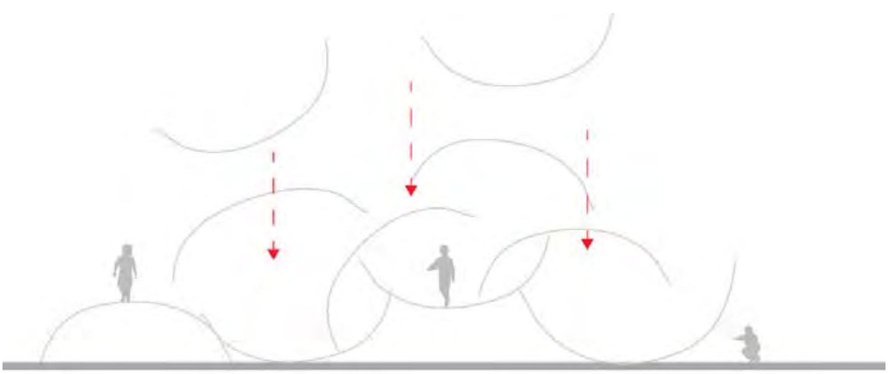


Fig 84: Diagram showing the process of form making

Fig 85: Physical model view 2

Fig 86: Physical model view 3

Spatial Experiment 3: (Layering of floors)

Architecture is often designed through a principle of having a defined floor, staircase, and a wall. This was a study on allowing the floor to be the stair as well as floor. By creating intermediate floors, the floors can act as a stair and a floor, and this has a potential of creating a landscape of planes through a series of floors in different heights. There is a primitive thinking of how a person can inhabit the space through their own imagination by using these undefined floor planes.

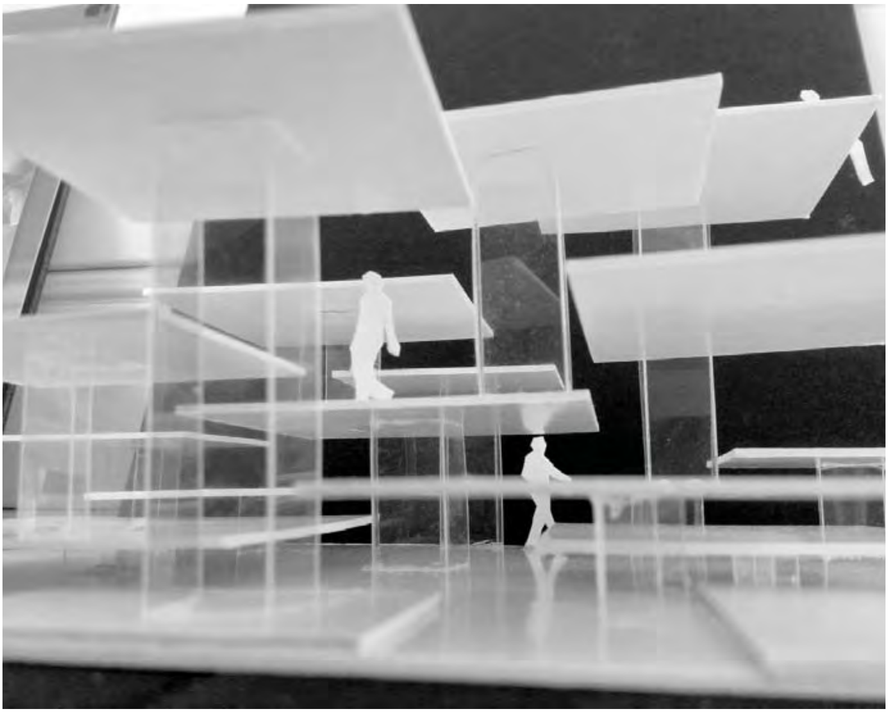


Fig 87: Physical model showing the spatial quality

Fig 88: Sectional diagram showing the floor levels

Fig 89: Plan diagram showing the layering of floors

Fig 90: Physical model

Spatial Experiment 4: (Glass wall with different penetration level)

The level of transparency of glass is determined by the frosting of the glass. When the transparency level is low, transparent material can be used as a solid by layering the same material over and over.

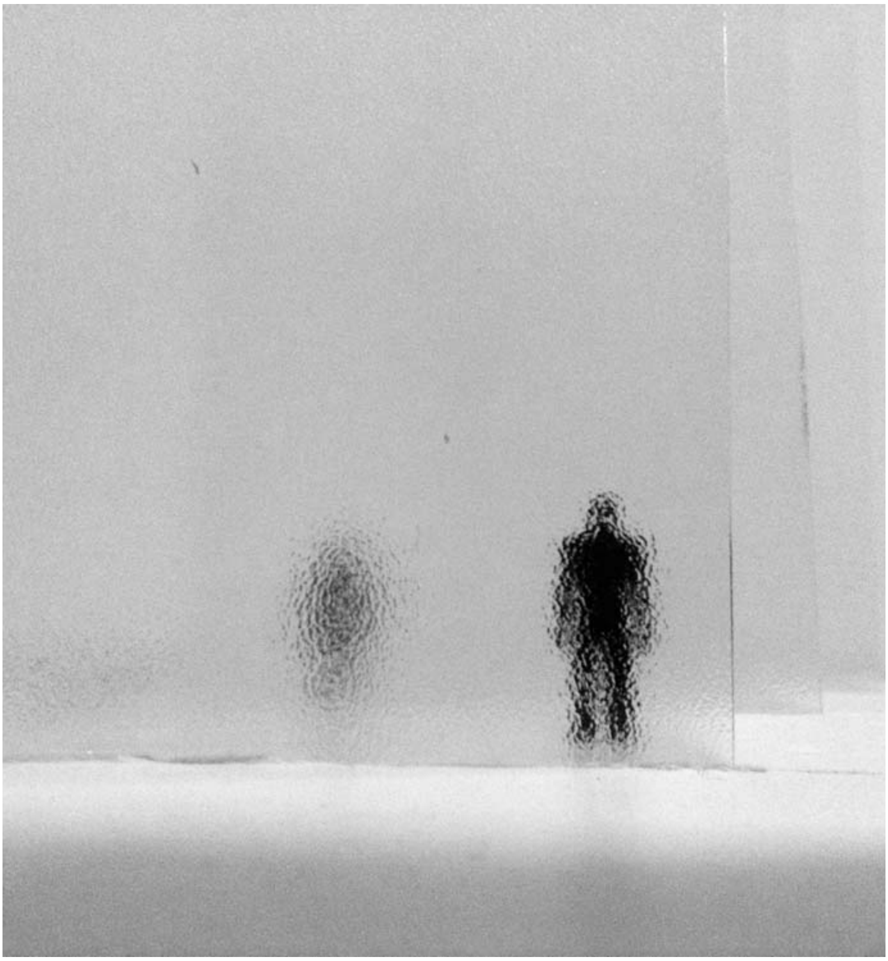
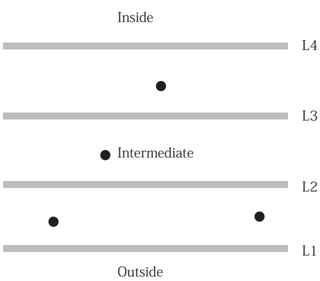


Fig 91: Transparency levels determined by layering.



Diagrammatic plan

Diagrammatic Elevation

Fig 92: Diagram showing the transparency level

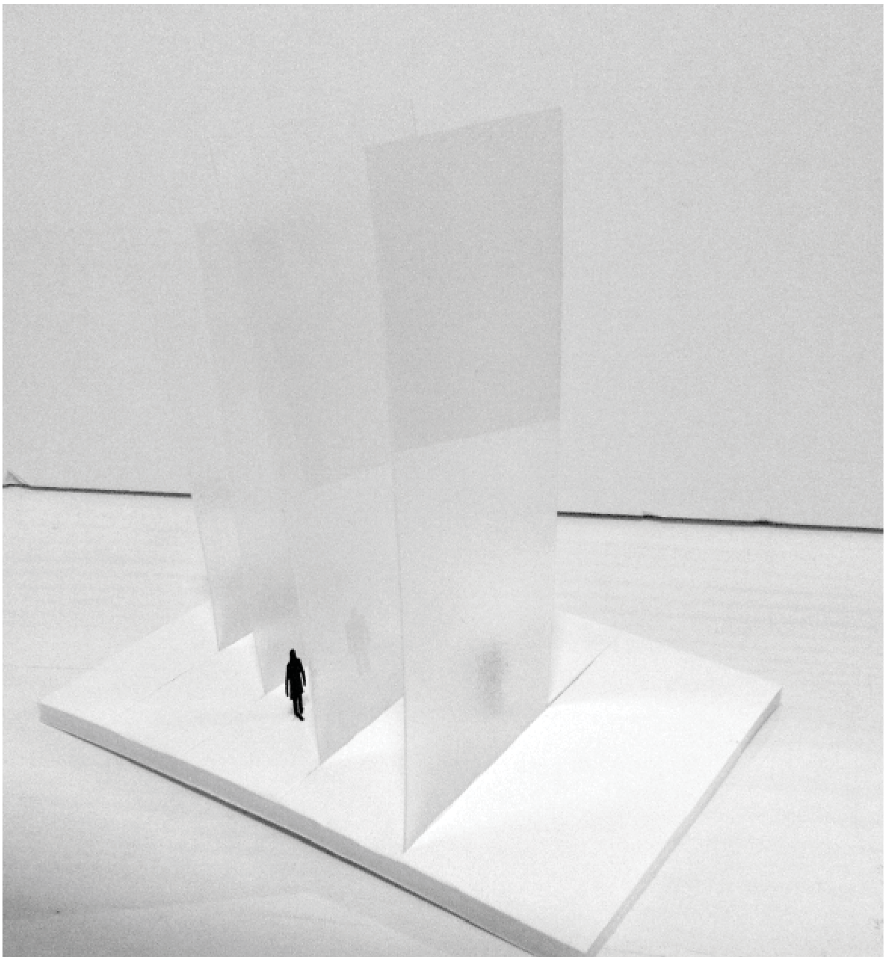


Fig 93: Diagramatic physical model

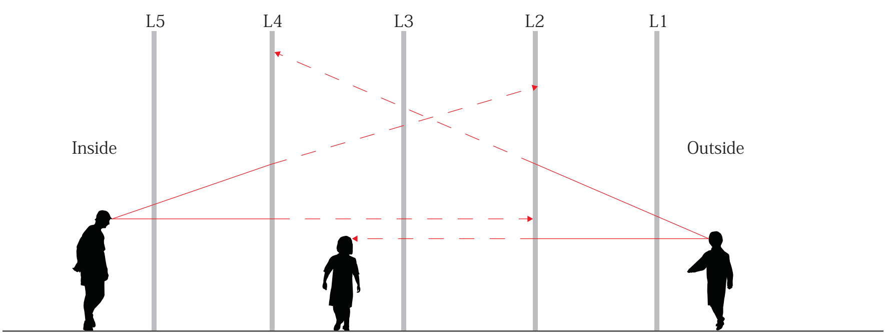


Fig 94: The person standing on both side of the end can see the middle girl, but cannot see the person on the otherside.

Spatial Experiment 5: (Network of structure)

This exposed framework is supported through a network of each element. Each element supports each other to allow the structure to stand. However this structure is a self-supporting structure and it is difficult to carry the load above. This membrane allows the person to experience the singularity of the structure as a whole.

Fig 95: Diagramatic physical model

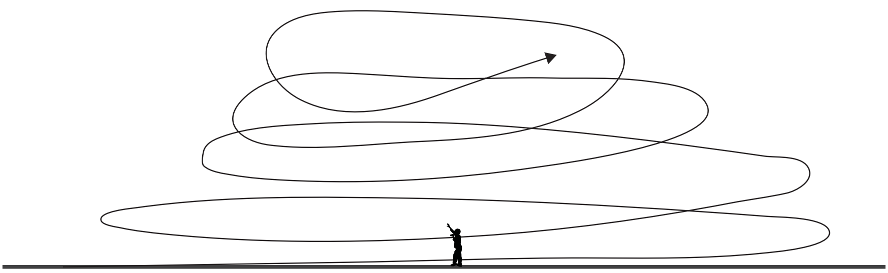


Fig 96: Diagramatic section

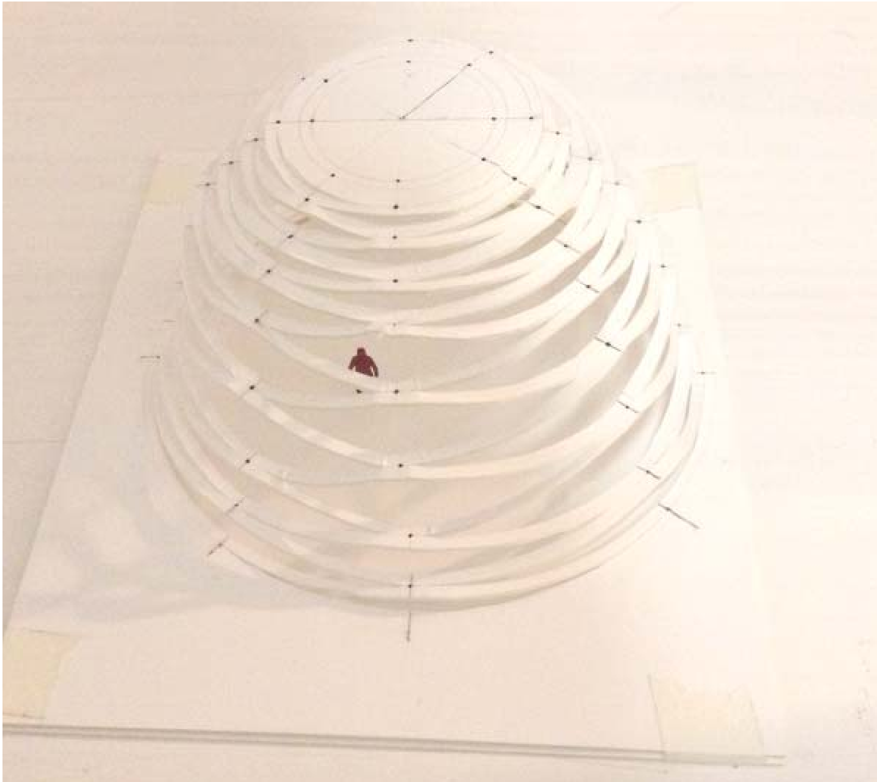


Fig 97: Diagramatic physical model top view

Fig 98: Diagramatic physical model side view

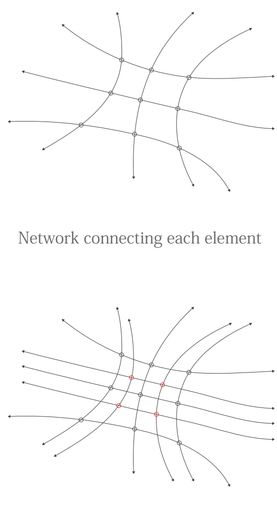


Fig 99: Diagram Sketch

Spatial Experiment 6: (Cave space and the geometry of an organic form)

This was a conception of creating a space without a wall, and how the wall and the roof becomes a singular component.

Fig 100: Physical model, cave like space

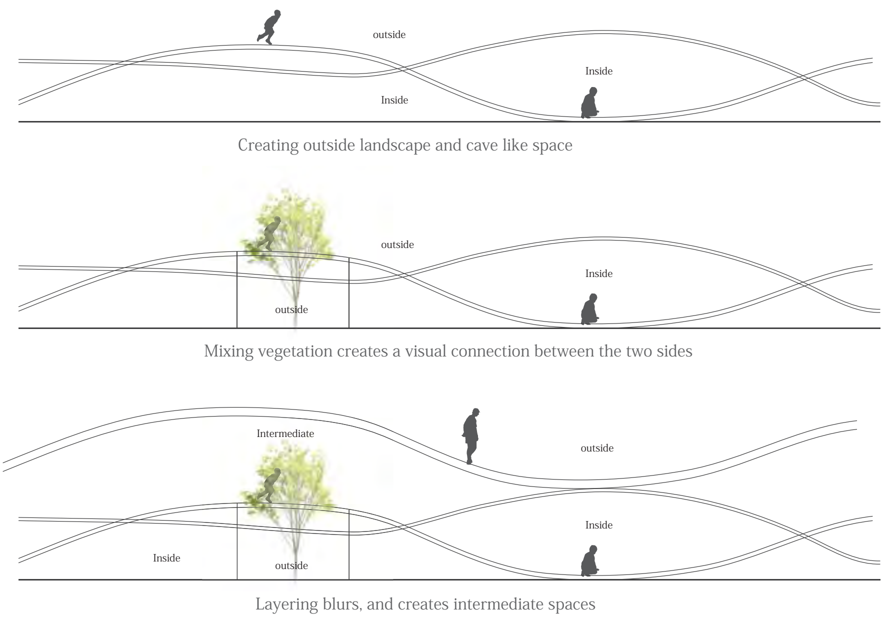


Fig 101: Sectional Diagram

Spatial Experiment 7: (Structure floating on sand)

This was a conception of creating a space without a wall, and how the wall and the roof becomes a singular component.

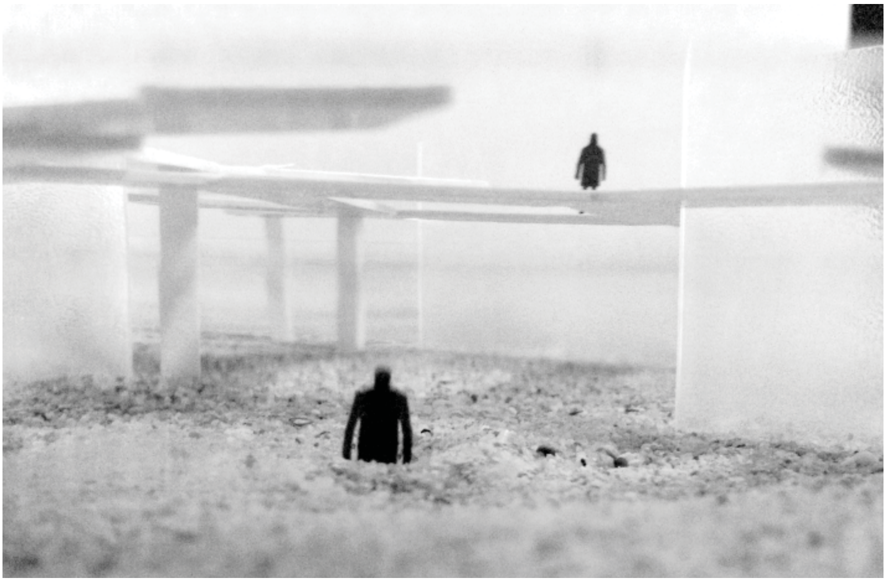


Fig 102: View from the sand level, physical model

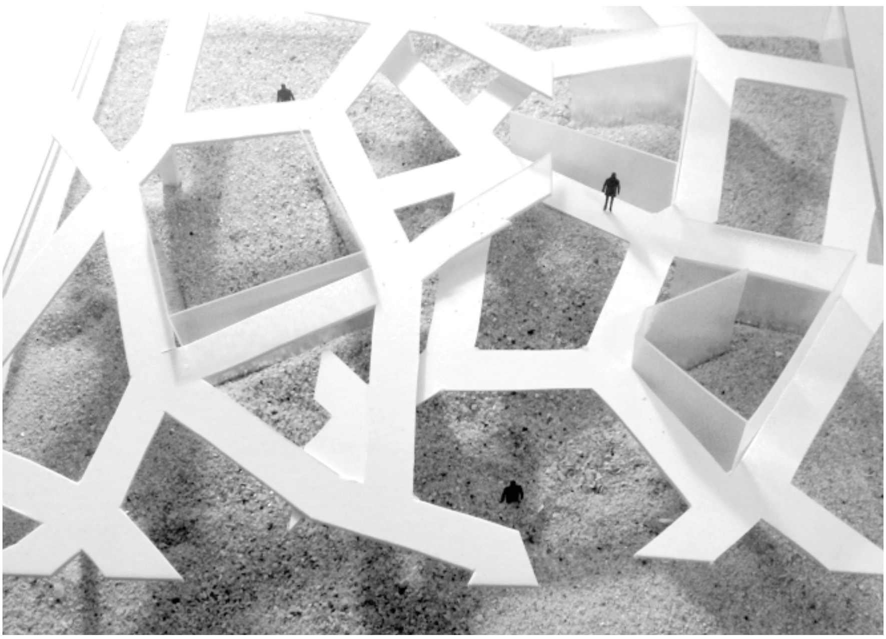
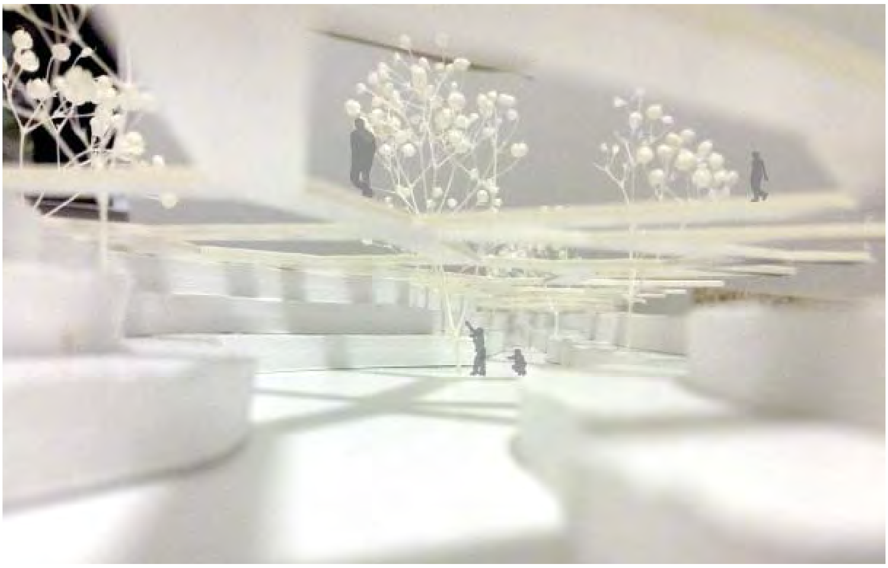
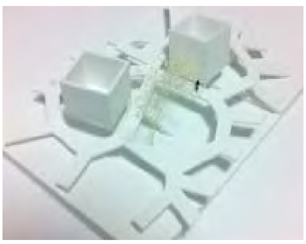


Fig 103: Top view, showing the pathway network

Spatial Experiment 8 (Sketch Design): (Network of pathway and integration with nature)

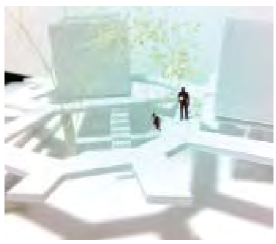
Through an investigation of an existing trees and plantation on site, I have used a Voronoi algorithmic pattern to create a network of pathway that floats above the vegetation. This pathway allows the people to interact with nature, and creates accessibility to interact with the surrounding.





View 1

View 2



View 3

Fig 104: Physical model

Spatial Experiment 9: (Roof and column reading as a singular component)

The concept of molding a space creates a singularity to the material as a whole, and the spatial character of this space reads as an irregular disorder which allows the space to become a unique and unusual interim.

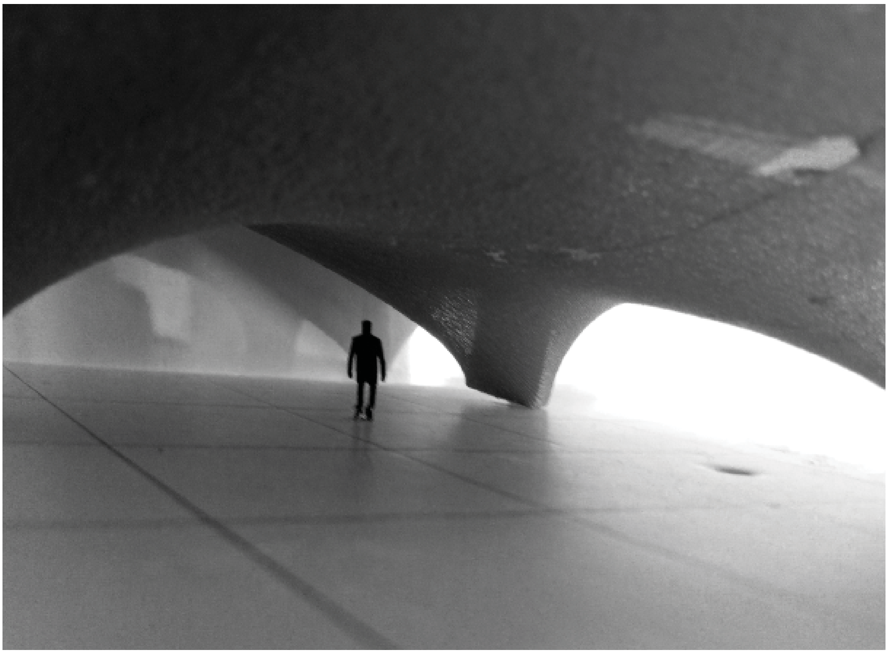


Fig 105: Roof undulates to a column

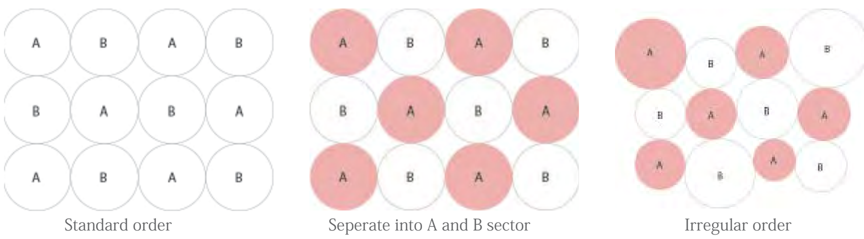


Fig 106: Diagrammatic plan

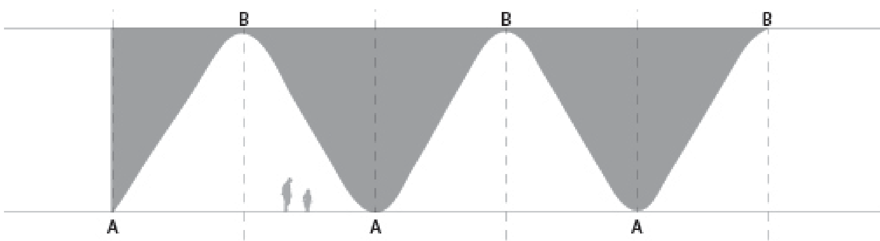


Fig 107: Diagrammatic section: extruding and stretching per sector to create a cave like space

Design proposal (Form and Space):

The above analysis, investigation, and the morphogenetic process driven the design to a process of computer and mathematically resolved design, integrated with the normative architectural practice. The integration contains different aspects of the surrounding nature and natural forces. The natural environmental forces that affect the site are too convoluted and enumerable to simulate the process to their full extent. Therefore the simulations were limited to only few factors that would hold the most influence in the mutation. Compared to a normal design process, this design involved series of computational analysis, as well as algorithmic pattern making and merging with the traditional process of design. The algorithmic and parametric tools work consecutively on the proposed building so the form will settle over different prodigies.

The environmental toolset gained from the site analysis is applied to the seed with varying parameters. Seed is a source where all the requirement and conditions are set to start a pattern. Incorporating the seed into a specific algorithmic pattern forms a series of shape, until the pattern reaches to a settled form. The purpose of this method was to understand the cumulative effects on the environmental forces and their distribution over the building site. The environmental forces affected the geometry mostly on the riverside of the building. The sand circulation changes the geometry of the east façade but the inner geometries are not affected through this process of circulation. The geometry of this proposal was processed through two transitional manners.

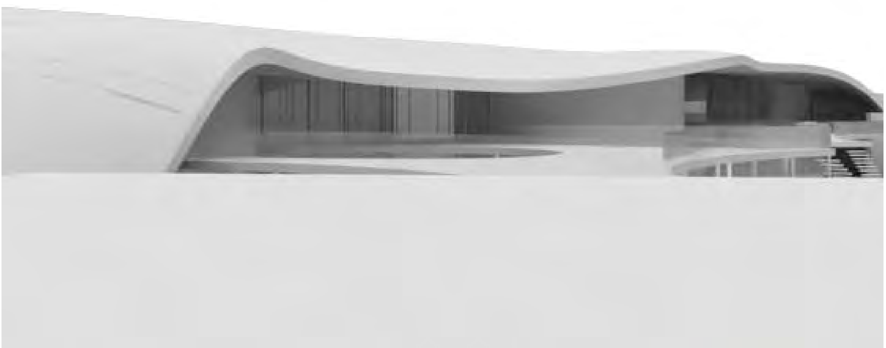


Fig 108: Proposed street view

Fig 109: East elevational view, expressing the glass curtain wall, Biostone wall, and roof relationship

The first method was dealing with the contextual appearance and the impact of the proposed building. The site is dominantly over flowed by the sand and plantation. In order for the building to fit into this context, the building needed to reflect the surrounding environment. The strong presence of existing dunes across the site is well emphasized in Hout Bay, and the proposed building would be an ideal reflection of the existing dune system. The study of the dunes allowed me to investigate the roof geometry and formation. The mutation of the roof was processed through a theoretical background of the dune. The process of form making involved several natural forces such as, wind direction, wind velocity, friction, and materiality. The form started from a flat plane and developed into a dune like shape through the forces of a south easterly wind. With the process of this formation, the form was edited through functional programming underneath the roof. The roof was finalized into a well compromised form between the two processes and serves both side of the result.

Fig 110: Finalised roof form and openings

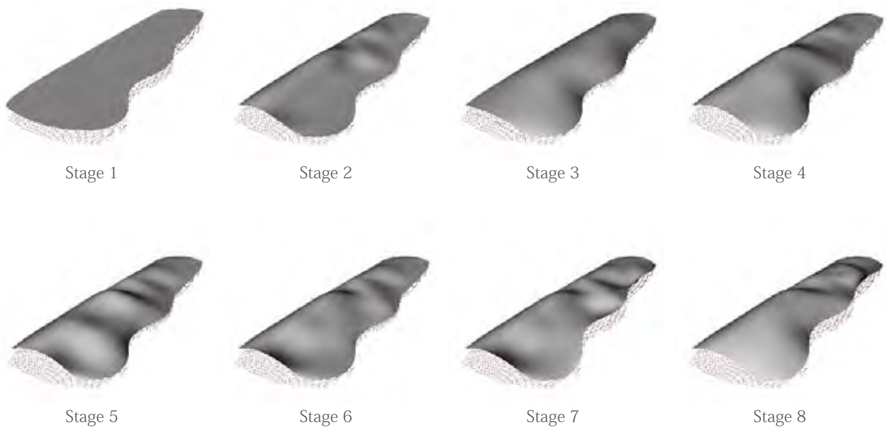


Fig 111: Development of roof form

The second method deals with the general process of organism's growth. If we perceive the building as a type of organism in nature, the building would need to follow a similar pattern of growth as the living organism. The process of cells in organisms has a pattern called Voronoi cell, which is a pattern that is created between the cells to protect the seed. This pattern is created through an adaptation from the existing natural forces. Since nature is connected through a network of living organisms, the building needed to be connected with the rest. The algorithmic process of this Voronoi cell consists of points of parameters to mutate into a geometric form. Therefore it was an ideal decision to use the existing trees on site as a point of reference to run this pattern. This allows the building and the pathways to avoid the existing trees and plantation on site; as a result a grid was created according to this pattern. This grid system allowed me to use as a base of order for the rest of the design.

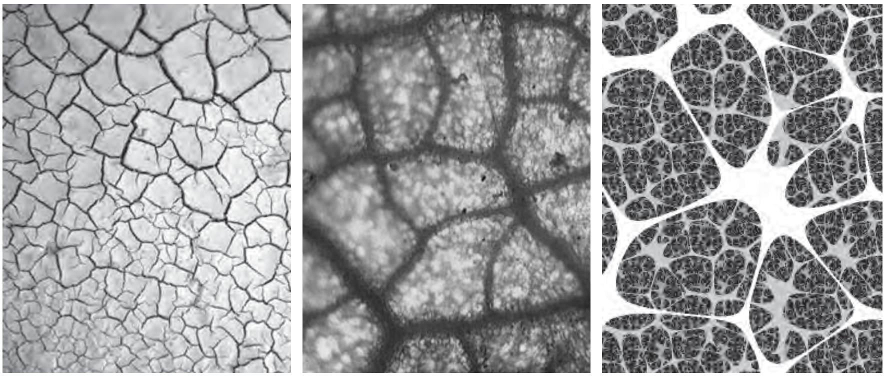


Fig 112: Voronoi algorithm found in nature, and used as a process of design

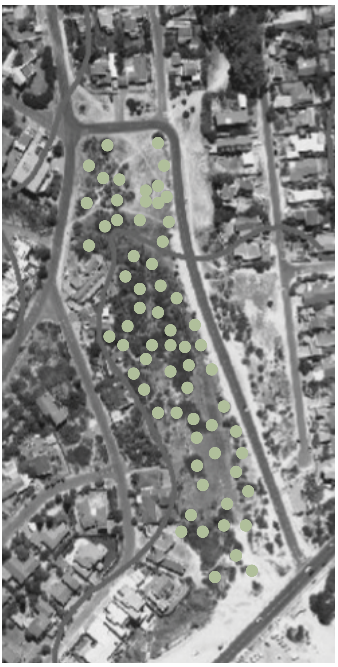


Fig 113: Existing trees on site

Fig 114: Selected existing trees are used as parameter points to apply the algorithm

Stage 1 : selected trees used as points of parameter.

Stage 2 : the points spreads through a circular radius

Stage 3 : Circular boundary forms bonding within each other

Stage 4 : Pathway created through the boundary grid line

Fig 115: Process of Voronoi algorithm on site

Fig 116: Diagrammatic development plan: The building is designed through a voronoi grid. The pathway created by the grid determines the program spaces. The pathway continues further along the side with this grid system to allow people to access the site. (Red line indicating the Voronoi grid)

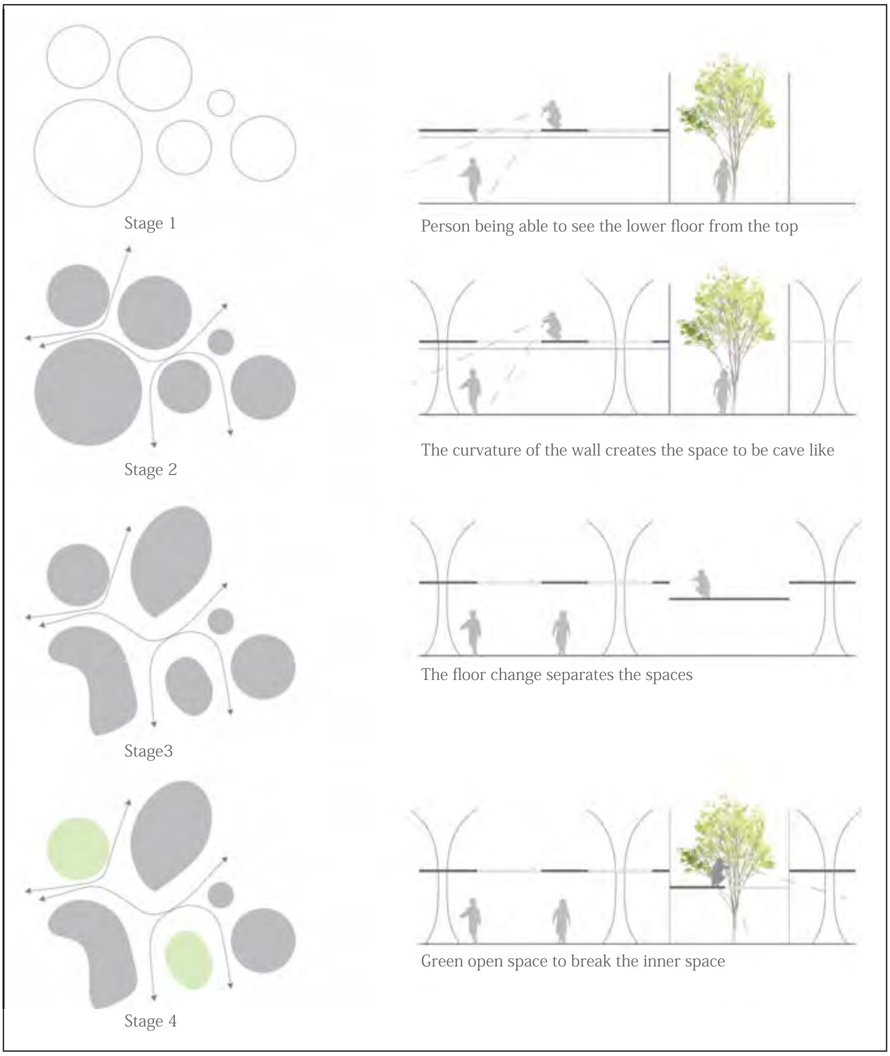


Fig 117: Diagram explaining the spatial characteristics and process

The transitional manner between the two methods was then combined with the functional aspect of design. The normative design process still needed to be approached. The two manners were well coincided due to the functionality and programmatic aspect of the building. During the process of unification, the previous process of corridor design was involved to deal with the existing natural forces and the circulation of the sand flow.

The last layer of this process was the prediction of sand accumulation and flow. The columns, walls, and roof are designed according to the prediction of the accumulation. Predictions are made through a series of testing and experimentations through the process. This accumulation of sand allows the building to form its final shape.

Fig 118: Design development: Entrance view

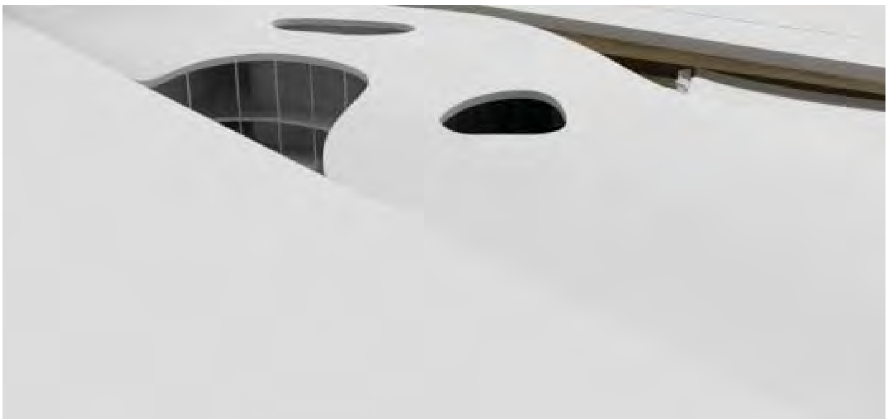


Fig 119: Design development: View from the above neigbouring residential complexes

Fig 120: Design development: Birds eye view

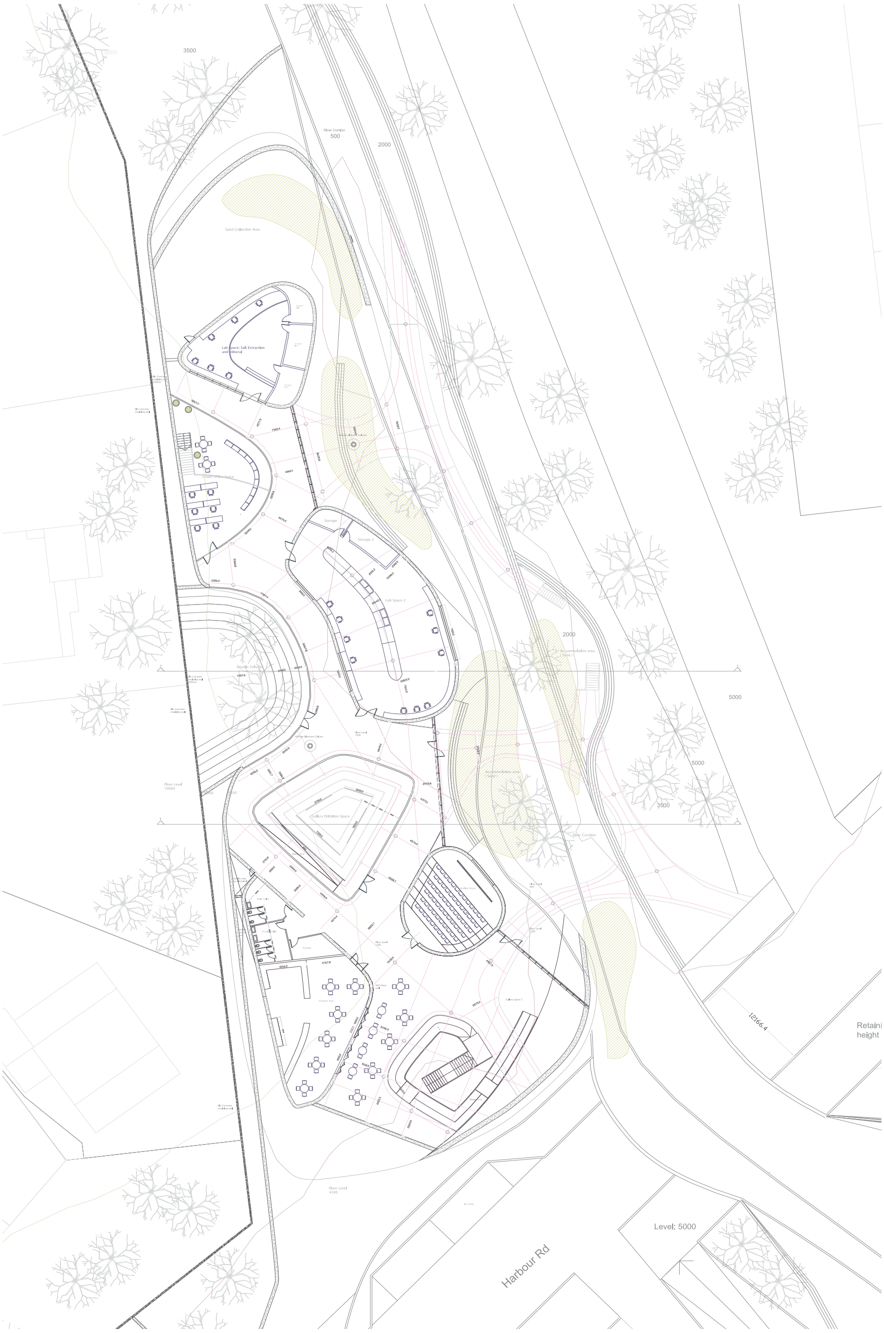


Fig 121: Design development: Corridor plan

Material and Texture

The materiality of this building was based on the use of beach sand as a way of construction method. Generally in a standard construction, the sand that is used comes from the riverside, as it does not contain any salt in the sand. The beach sand contains salt in the sand, and creates many problematic issues in construction.

The material I have researched is called Biostone. This material has being tested and research through several professors of Architecture and Ecologist around the world (Larson 2010), and has been acknowledged as a potential material replacement for concrete.1 Through the research of the professors, they have found that 1 kilogram of concrete requires 5.6megajoules of energy to produce, whereas the equivalent amount of Biostone contains only 0.9megajoules of energy to produce.2 The flexibility of this material allows it to mold in the same way and has a strength capacity of a concrete. 3

The process of Biostone is extremely simple and the material is made through a natural formation. The material is developed through a mixture of urea, calcium chloride and the bacteria called Bacillus Pasteurii.4 The material solidifies within few days through a process of bacteria bonding the sand grains together to form a Biostone. This procedure eliminates the need to burn coal or other fuel to heat, which common bricks production requires.

Biostone allows an opportunity to not only structurally formulate a building, but also creates a possibility to use beach sand as a construction method for the future development in Hout bay.

Separate to this material, glass and Aluminum frame will be used for openings and exposure. Structurally the Biostone post tension structure will be supported through a series of steel caballing.

1 Mike Larson, Professor Uses Bacteria To Make Eco-friendly Bricks, (2010). Available at http://enr.construction.com/products/materials/2010/0707-EcoFriendlyBricks.asp. (accessed on 3 June 2014)
2 Ibid. Pg. 2
3 Ibid. Pg. 2
4 Ibid. Pg. 3

Fig 122: Using existing sand on site as a construction material

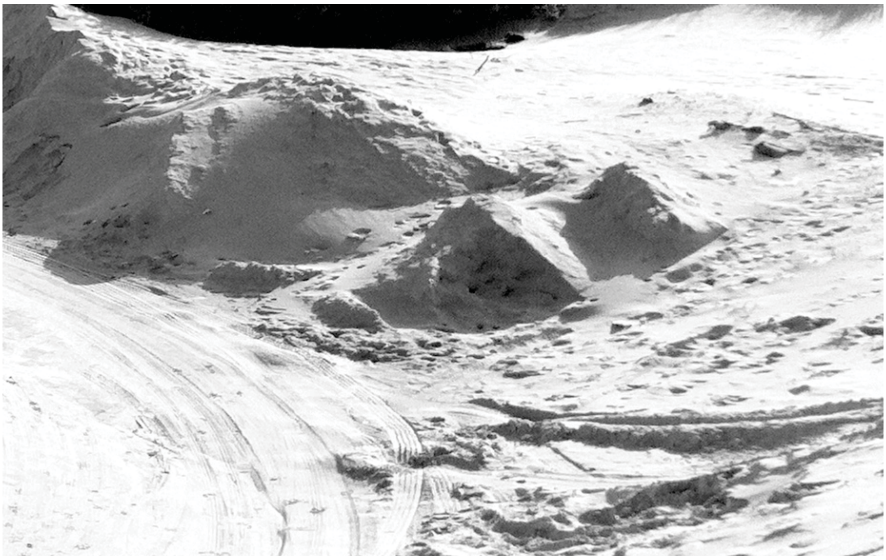
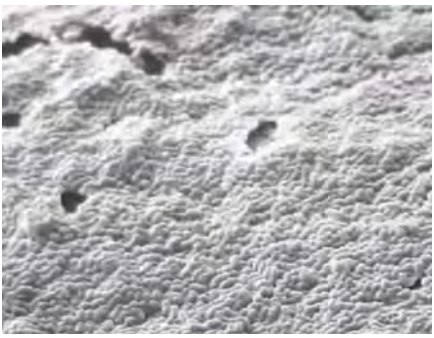
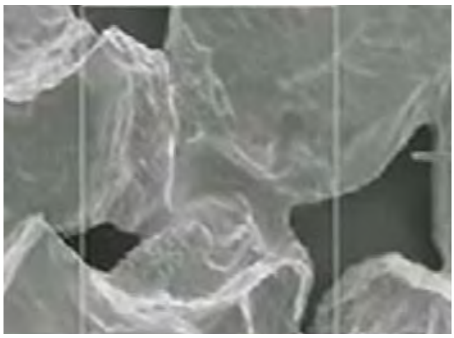


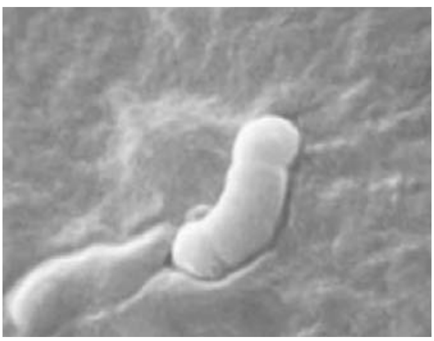
Fig 123: Existing sand around the site



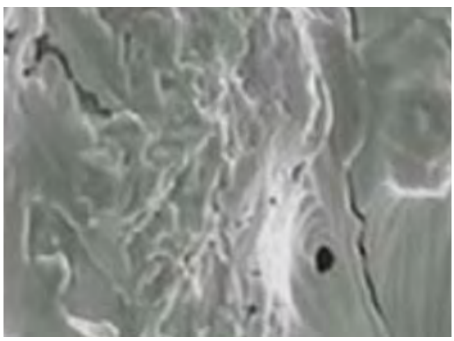
Macro view: Sand grains



Grains bonding by bacteria



Micro scale: bacteria bonding the grains



Grains bonded as one component

Fig 124: Diagram explaining the Biostone material process. Each sand grain bonds through bacteria.

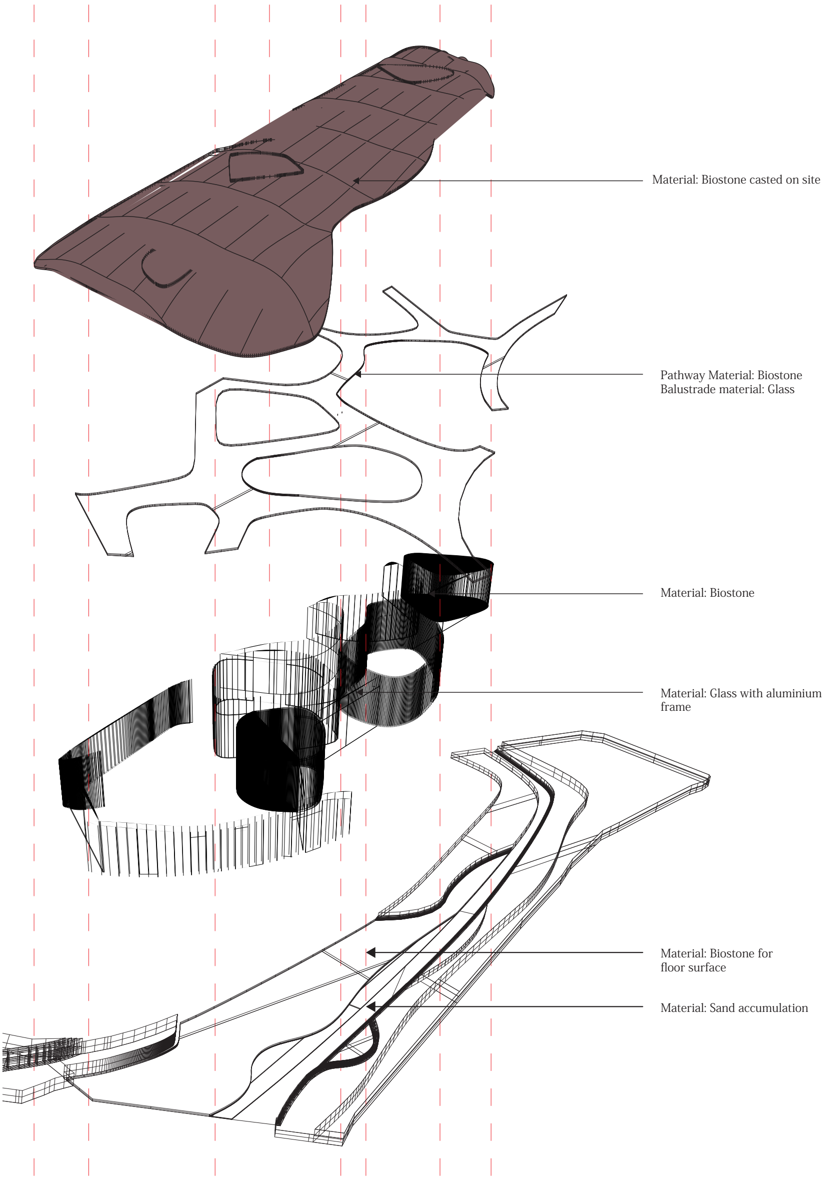


Fig 125: The building is formed through three conditions of using sand: Glass, Biostone, and natural sand accumulation

Structure and process of construction

The building is essentially one continuous structure spread over a site of 4048m2. The roof, column and the floor slabs are made out of the material called Biostone. Because this is a new material with very minimal experience on site, I have used the same constructional method as standard concrete construction. The roof undulates gently onto a column like shear wall, which again undulates onto a floor. For the 3 dimensional curved Biostone roof shell, I have worked with a structural engineer to calculate the maximum spans and to find the shapes with the least bending stresses. The Roof is constructed as a post tensioned Biostone construction, which will be cast on site. The roof is 600mm thick with steel reinforced wires which will be tightened to strengthen the structure through compression. The formwork will be constructed in situ, and the sand will be watered temporarily stabilize in order to fit into the formwork. The bacteria and urea will be poured during the process to solidify the material. The 400mm thick shear wall is cast in conjunction with the roof and the slab will be placed after to be fixed. Due to the thickness of the shear wall and the span, the building allows a large free space with minimal structural exposure. The internal spaces will be fixed with glass curtain walls. The glass will be treated accordingly dependent on the program, and the shape of the roof.

The proposal pushes the boundary of construction, materiality and process of architectural design, however computation, mathematics, bioengineering, and fabrication industries are in the process of fundamentally changing the design professions, and in the next few years, construction of what is now impossible will be standard.

Fig 126: Roof is constructed with post tension cables and biostone material

Conclusion

This dissertation suggests a new process methods for architectural design based on observation and inspiration from nature. Morphogenetic process of design not only allows designers to work outside the norm but also to work with scientists, engineers and biologists to redefine the potentials of collaboration between the language of science and design could hold. The collaboration with other industries and the new process of design can open up to a new possibility of dealing with nature. In order to dissolve the boundary between architecture and nature, we need to begin to redefine the process of design. By using nature as a metaphor for building, the designer's range in which to explore forms, materials, connections and systems opens up to a greater extent. The advancement of technology and mathematics can allow us to gain access into critical information not even yet known. Nature's complexity can be answered through mathematics and science, and the relationship between people and nature can be answered through architecture.

Glossary

Algorithm – is a set of instruction or a rule usually expressed in an algebraic notation that gives a solution or an answer to a problem through patterns

Biostone – is a material developed through a mixture of urea, calcium chloride and the bacteria called Bacillus Pasteurii.

Ecology – is a study of interactions between each organisms and their environment.

Euclidean geometry – is a mathematical system created by Alexandrian Greek mathematician, Euclid. It is a geometry set through a logical system and simplified to use.

Morphogenesis – is a process of evolutionary development and growth that causes an organism to develop its form through the interaction of system-intrinsic capacities and external environmental forces.

Mutation – is a development stage of form during the process of computational design.

Non-Euclidean geometry – is when the metric requirement is relaxed, and naturally settled. Geometry created through a natural process.

Parameters – is a type of variable, creating procedures, used often as sub passages, where routines are defined and allows the person to plot numbers to create different forms.

Parametric relationship - is when a value of the variable corresponds to different distributions, and therefore when the parameter of the equation changes, the solution changes.

Quaternary sediments – is a division of geological time shown through the types of sediments.

Seed – is a source where all the requirement and conditions are set to start a pattern.

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Ethic Clearance

EBE Faculty: Assessment of Ethics in Research Projects (Rev2)

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zulpha Geyer (Zulpha.Geyer@uct.ac.za; Chem Eng Building, Ph 021 650 4791).
NB: A copy of this signed form must be included with the thesis/dissertation/report when it is submitted for examination

This form must only be completed once the most recent revision EBE EiR Handbook has been read.

Name of Principal Researcher/Student: Ryuya Yamawaki Department: ARCHITECTURE, PLANNING AND GEOMATICS

Preferred email address of the applicant: yamawaki.r@gmail.com

If a Student: Degree: MArch(Professional) Supervisor: NIC COETZER & MELINDA SILVERMAN

If a Research Contract indicate source of funding/sponsorship:

Research Project Title: MORPHOGENESIS OF NATURE AND CHANGE AS A PROCESS OF ARCHITECTURE: SEA SAND MANAGEMENT STRATEGIES AT HOUT BAY.

Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	YES	NO ✓
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	NO ✓
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	YES	NO ✓
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	YES	NO ✓

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate. Ensure that you refer to the EiR Handbook to assist you in completing the documentation requirements for this form.

I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	RYUYA YAMAWAKI signature removed	22/09/14
This application is approved by:		
Supervisor (if applicable):	signature removed	23/09/2014
HOD (or delegated nominee): *Final authority for all assessments with NO to all questions and for all undergraduate research.*	signature removed	09/10/2014
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.		

ADDENDUM 1:
Please append a copy of the research proposal here, as well as any interview schedules or questionnaires:

Introduction:

The investigation of boundaries between the natural environment and the urban development is extremely distinct and well defined. We living in the city where we separate ourselves from the nature and we see nature as a visiting point. However what if there was a way to blur or dissolve the boundaries by building an architectural space, which contributes, and blends with the nature and at the same time heightens and celebrates the nature of the site. By creating a new typology of architecture through the hybridization between a natural system and architecture, will give a massive potential to the new way of developing an architectural design. By emerging the architectural process and the natural system, there is a possibility of creating a new system, to create a different and new synthetic architectural space through the movement and change of nature.

I am proposing a new contract to the relationship between architecture and nature. The geometry and formation of spaces that are created in nature are all compromised within each element and living organisms. Everything is adapted to a certain condition and feeds within each other to support each other. The individuality of manmade architecture has always being difficult to be adjusted to this environment, and has often destroyed the natural environment. My proposal is to create a sensitive geometry that accommodates the movement of natural growth and settles into a natural cycle through a bond between an architectural and natural system. Architectural form will always be static, however the movement of nature will always change through time, and through this movement of nature, an architectural space will change. Space changes as the nature changes and this connection allows the person to interact with nature through this moving space. Prediction of natural movement through series of time will allow the geometry and space to be designed to accommodate series of experiences according to the change and allows architecture to be part of a natural cycle.

The focus of this theory will be based in Hout Bay and the research and my dissertation will be on the rehabilitation of the sand dunes through the investigation of the above theory.

Research Plan:

My research will consist of site visits, gaining information from the observation of the site, and investigating on the samples from the site, as well as the time line of the condition of the site. The historical analysis will involve references from books and drawings. The research of natural system and the geological and ecological condition of the area will be consulted and received from a professional as well as support from references. This information will be broken down and analyzed in order for it to help into the final design of my dissertation.

Method of gathering information:

My research methods will consist of interpreting and comparing or contrasting primary resources. I will also use biographical and historical materials in order to establish the different geological conditions and study through investigations on site and consulting and gathering information's from professional geologist, ecologist, city planners, engineers, and developers of each area. I will analyze my findings with a significant number of resources and compare and combine to create a new finding. Info from professionals in terms of info data sources [Field Kigufn to info]

Method of presenting and analyzing information:

From the gathering of the information of the qualitative data, I then will be able to compare the different types of information from different conditions and to see if there is any relation to each other and what the effects and problems are. To an addition the collection of Professional data, and field notes will give a scientific result and this will lead to a potential of design options, however the collection of different data should define a repetitive pattern which shares between each condition on site, and may lead to a result of how a new space may be designed. The presentation of this information will be in a timeline and mapping form, which shows where, and what each condition are, and to compare if there are any relation between conditions and the differences. The professional data and site notes will be formed in documents, which will be separated according to different conditions.

Significance of the project:

The result of this research may result with a new set of theory for designers to base and to adapt, as well as a possible solution to the sand dune circulation in Hout Bay.

ADDENDUM 2: To be completed if you answered YES to Question 2:

It is assumed that you have read the UCT Code for Research involving Human Subjects (available at http://web.uct.ac.za/depts/educate/download/uctcodeforresearchinvolvinghumansubjects.pdf) in order to be able to answer the questions in this addendum.

2.1 Does the research discriminate against participation by individuals, or differentiate between participants, on the grounds of gender, race or ethnic group, age range, religion, income, handicap, illness or any similar classification?	YES	NO
2.2 Does the research require the participation of socially or physically vulnerable people (children, aged, disabled, etc) or legally restricted groups?	YES	NO
2.3 Will you not be able to secure the informed consent of all participants in the research? (In the case of children, will you not be able to obtain the consent of their guardians or parents?)	YES	NO
2.4 Will any confidential data be collected or will identifiable records of individuals be kept?	YES	NO
2.5 In reporting on this research is there any possibility that you will not be able to keep the identities of the individuals involved anonymous?	YES	NO
2.6 Are there any foreseeable risks of physical, psychological or social harm to participants that might occur in the course of the research?	YES	NO
2.7 Does the research include making payments or giving gifts to any participants?	YES	NO

If you have answered YES to any of these questions, please describe below how you plan to address these issues:

ADDENDUM 3: To be completed if you answered YES to Question 3:

3.1 Is the community expected to make decisions for, during or based on the research?	YES	NO
3.2 At the end of the research will any economic or social process be terminated or left unsupported, or equipment or facilities used in the research be recovered from the participants or community?	YES	NO
3.3 Will any service be provided at a level below the generally accepted standards?	YES	NO

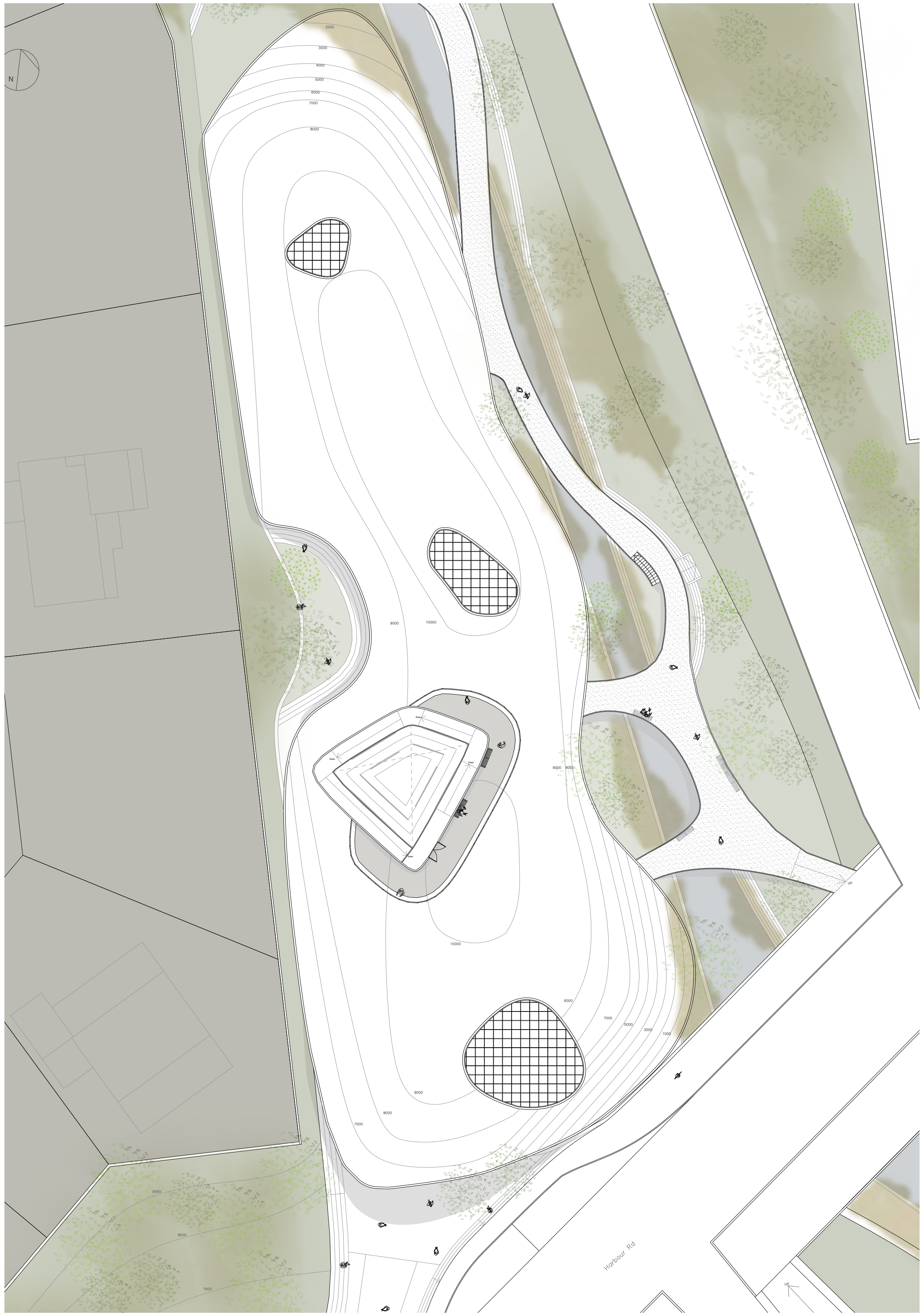
If you have answered YES to any of these questions, please describe below how you plan to address these issues:

ADDENDUM 4: To be completed if you answered YES to Question 4

4.1 Is there any existing or potential conflict of interest between a research sponsor, academic supervisor, other researchers or participants?	YES	NO
4.2 Will information that reveals the identity of participants be supplied to a research sponsor, other than with the permission of the individuals?	YES	NO
4.3 Does the proposed research potentially conflict with the research of any other individual or group within the University?	YES	NO

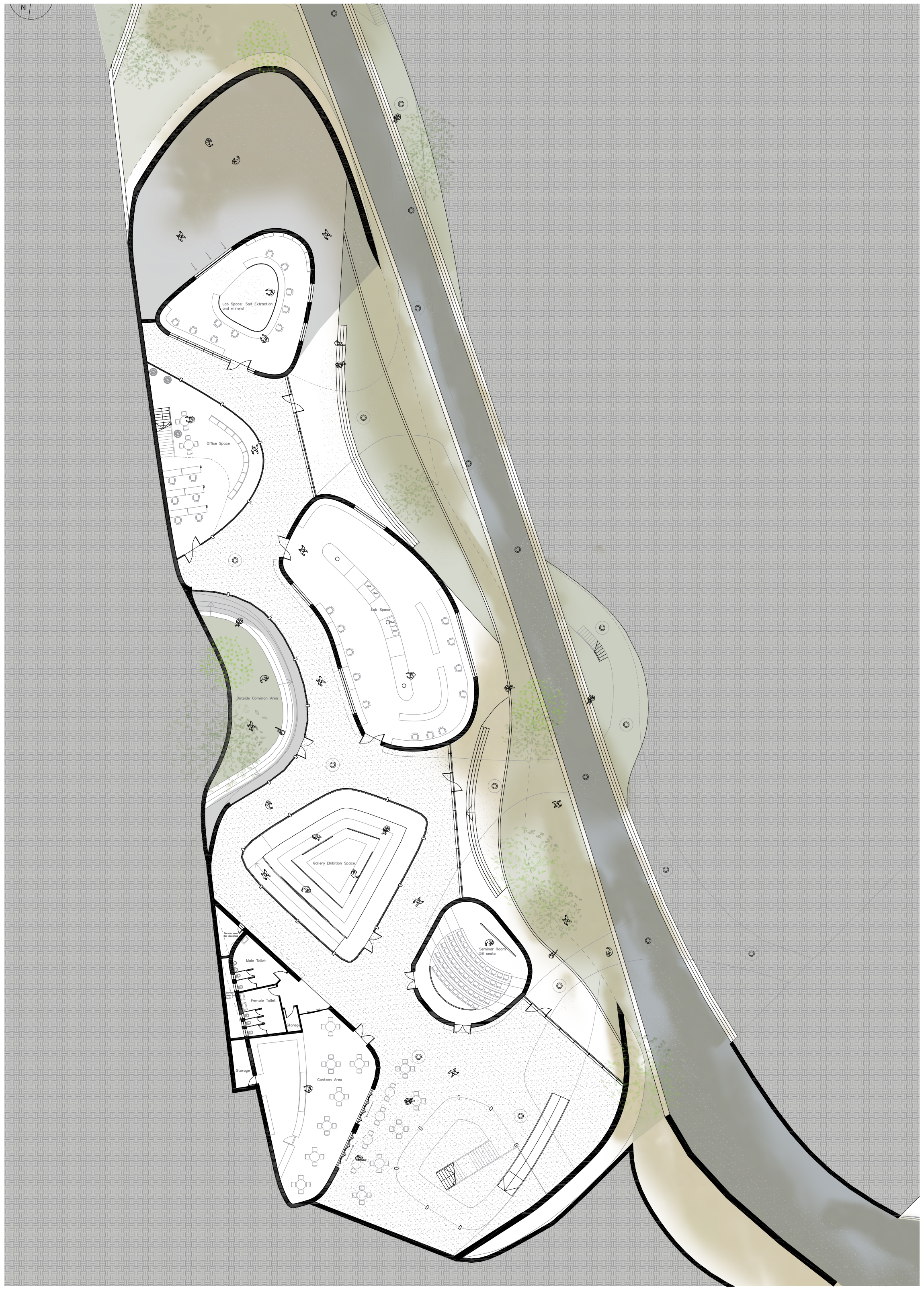
If you have answered YES to any of these questions, please describe below how you plan to address these issues:

Final Design

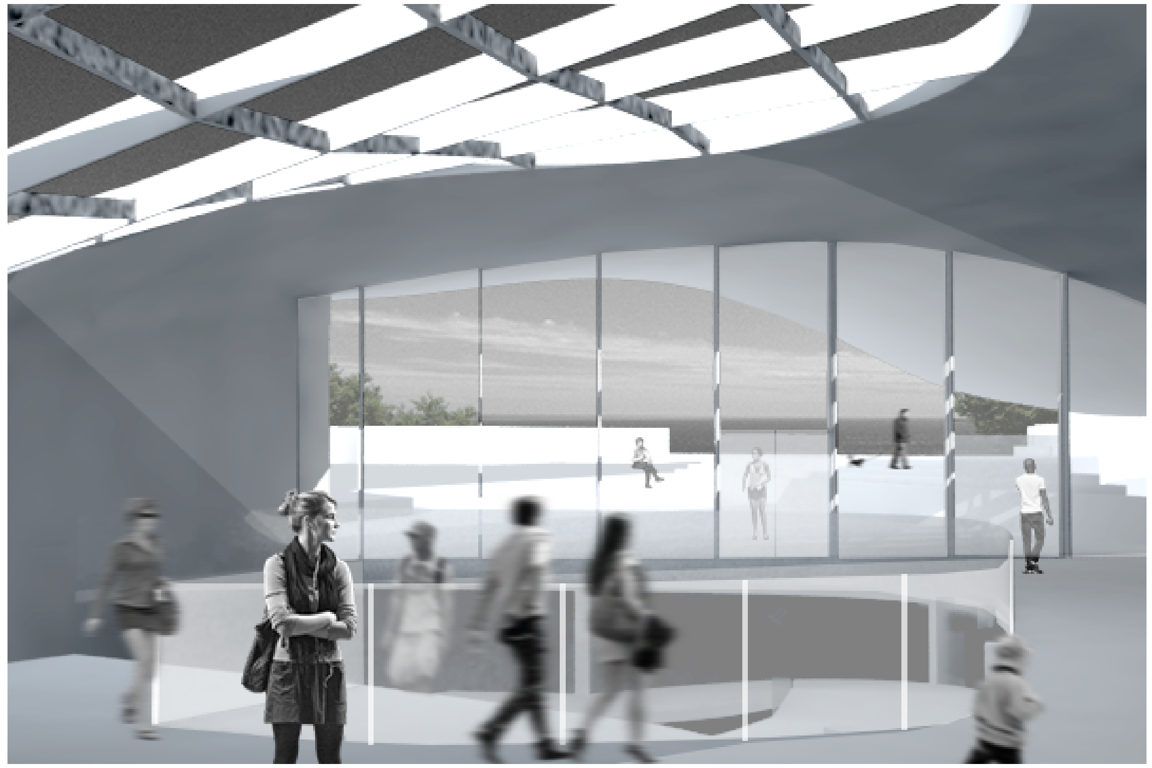


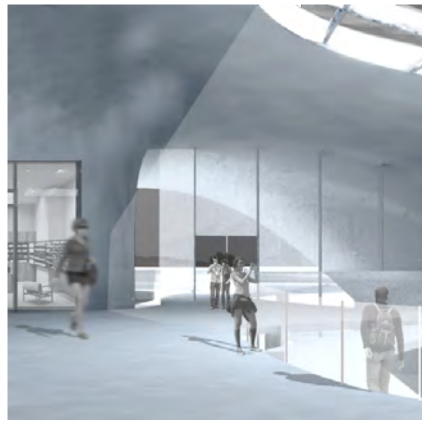
Roof Plan

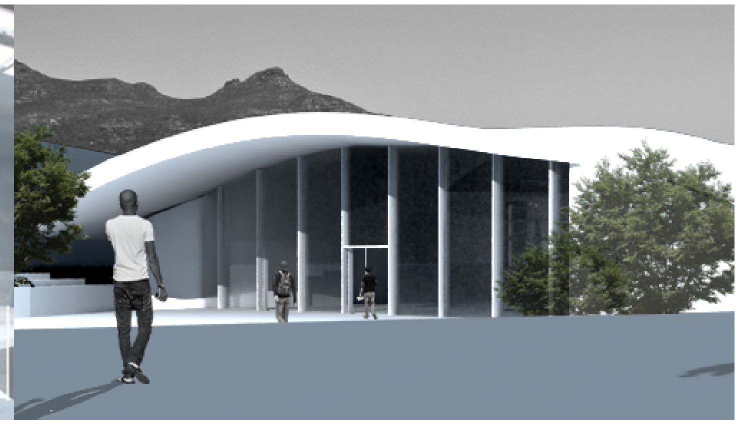
Street Level Plan

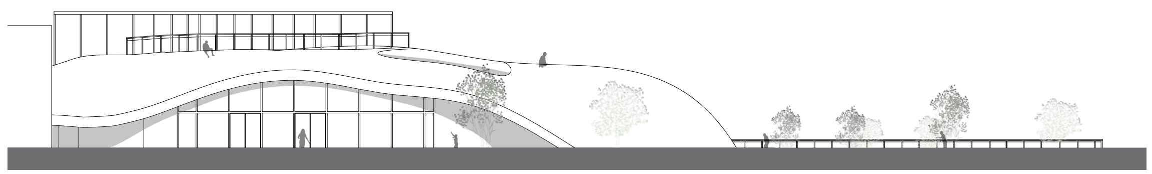


Sand Level Plan

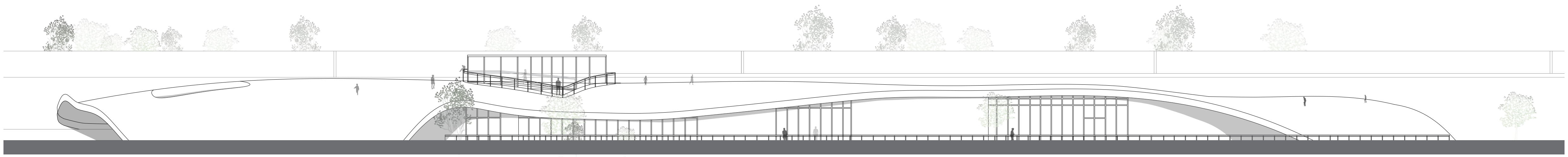




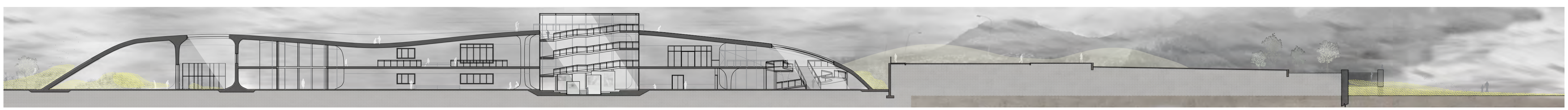




South Elevation



East Elevation



Section A-A